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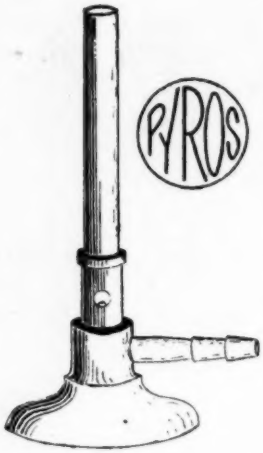

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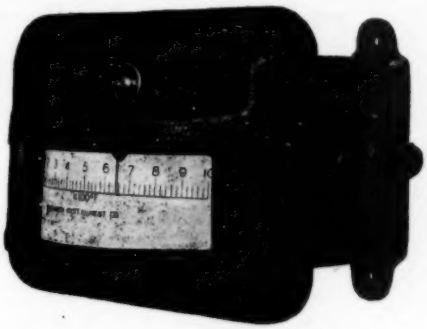

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CURRENT SCIENCE

Vol. XVI] JANUARY 1947 [No. 1

THE INDIAN SCIENCE CONGRESS 1947—DELHI

THE 34th Annual Session of this oldest scientific organisation marks a significant and memorable landmark in the history of the progress of science in India; it is the first and the most representative of the National assembly of scientists to be held after the formation of the Interim National Government. A singularly inspiring feature of this Congress is the fact that Pandit Jawaharlal Nehru, the Vice-President of the Interim Government, who, to quote his own modest words, "represents something of the new India that is rising around us", inaugurated the Session and presided over its deliberations. Pandit Nehru, it will be recalled, was invited to preside over the thirtieth session of the Indian Science Congress in 1943 which was planned to be held at Lucknow. For reasons too well known to need any repetition, Pandit Nehru could not preside over the 1943 Session of the Congress. To quote Professor D. N. Wadia, "Pandit Jawaharlal Nehru's contributions to science in India have not been in the limelight, but they have been leavening influence in the organisation and working of the National Planning Committee which since 1939 is engaged in the great task of co-ordinating applied science with productive industry in every field—industrial, educational, cultural and organisational."

Among the other distinguishing features of the Congress were the Delegations of notable foreign scientists who actively participated in the proceedings of the session. The British Delegation representing a "cross-section of British scientific life" was led by Sir Charles Darwin, the Director of the National Physical Laboratory; the Russian Delegation was headed by Professor M. Volgin, the Vice-President of the Soviet Academy of Science. Eminent men of science representing the United States, Canada and France, were also present at this historic session.

Pandit Nehru established a refreshingly new tradition by commencing his Presidential Address in the language of the land, which was later rounded off in English for the benefit of the visiting scientists. He expressed the hope that now, when India was on the verge of independence and science was coming of age, it would solve the problems of the new India by rapid, planned development on all sectors and try to make her more and more scientific-minded.

Pandit Nehru said, "Surely science was not

merely an individual's search for truth. It was something infinitely more than that if it worked for the community".

Pandit Nehru put forth an impassioned plea for a new orientation of scientific research in this country and emphasised the need for a much more broadbased effort to tap and harness the country's scientific talent in the service of four hundred millions who are faced with the struggle of securing the absolute wants of life. He said:

"For a hungry man truth has little meaning. He wants food. For a hungry man, God has no meaning. He wants food. India is a hungry, starving country, and to talk of truth, God and even many of the fine things of life to millions who are starving is a mockery. We have to find food for them, clothing, housing, education, health—all the absolute necessaries of life that every man should possess. When we have done that, we can philosophise and think of God. So science must think in terms of four hundred million peoples in India. Obviously, you can only think in those terms and work along those lines on the wider scale of co-ordinated planning."

The Science Congress, he said, should devote itself to this imperative task and not wait merely for the Government to take action. He wished to discourage among the scientists a reliance on what the Government may or may not do. He, however, recognised the legitimate right of scientists to expect certain initiatives from the Government. Speaking just as one Member of the present Government of India—partly for his colleagues but largely for himself—Pandit Nehru said, "We are intensely interested in the scientific dvelopment of India and we shall do everything in our power to encourage scientific research. We should like to tap all the latent scientific talent in the country and to give it opportunity for growth and service to the humanity."

The voice of a united India spoke when Pandit Nehru referred to the heralding of the Atomic age with the enactment of the horrible tragedy of Hiroshima. He would pledge to extend his whole-hearted co-operation to the promotion of all aspects of scientific endeavour in every part of the globe, in so far as it advanced the cause of peace, prosperity and happiness for all mankind. "But in giving that undertaking and pledge," declared Pandit Nehru, "I want to make it perfectly clear that we will not co-operate in the ways of war."

"What the future will bring I do not know. I can neither foretell the future nor have I any authority to bind my country down to what it may or may not do in future, but in these days so soon after the last war, when people again think of wars and when scientists are yoked into work in preparation for future wars, I think it is desirable and necessary that men and women of science should also think about the way they are often misused and exploited for base ends. I should make it clear that they do not want to be so exploited."

"Science has its destructive side and a constructive and creative side. Both have gone on side by side and both still go on. No one knows which ultimately will triumph. Hiroshima became a symbol of this conflict and in spite of all the decisions of the Atomic Energy Commission of U.N.O.—and we welcome those decisions of course, in so far as they go—that doubt remains in one's mind as to where we are speeding. On the other hand, apart from the atomic bomb aspect of it, obviously we are on the threshold of a new age, in the sense of enormous power resources being put at the disposal of the humanity and the community. Will this new age change—and I think it will change—enormously the whole structure of society? My mind goes back to the time when gun-powder burst upon the world. Gun-powder at any rate pushed the Middle Ages away completely and fairly rapidly and in course of time brought or helped to bring about a new political and economic structure. Of course, there were many forces at work; nevertheless, gun-powder did produce that powerful effect on society, and ultimately out of that feudal order gradually a new capitalist order developed. Now I wonder whether this so-called atom bomb is not also the herald of a new age, of a new structure of society which has to be established in order to fit in with present conditions. I myself am convinvinced that there is going to be no very great progress either in science or in other ways unless certain fundamental changes take place in the social structure."

Concluding his address, Pandit Nehru said that however engrossed in politics he was, he had always thought or tried to think in terms of a scientific solution for all problems of India. He firmly believed that the only right approach to the world's problems and to India's National problems was the approach of science. He hoped that this historic session of the Indian Science Congress, which had met at a time which is in India's history a very significant time, will prove also very significant in the development of science in India.

THE FUTURE OF SCIENCE IN INDIA

IN a message to the Thirty-fourth Session of the Indian Science Congress, held at Delhi, during the first week of January 1947, Sri. C. Rajagopalachari, Education Minister, Government of India, declared :

"India has in recent times produced eminent men of science, some of whom have found places in the front rank of world scientists. Young men are working in several research institutes in India at problems of first-rate importance. We may be sure that the genius of India will once again find expression in scientific research as it did in ancient times.

In no country in the world did intuition come so near to the discoveries and hypotheses of modern science as the intuition of the philosophers of ancient India. If there is any one centre which we could treat as the earliest starting point from where systematic scientific knowledge spread to all parts of the world, ancient India is entitled to that honour. The amount of astronomical and mathematical knowledge that we find in Sanskrit books is a matter for wonderment. There are some who, instead of tracing the current of knowledge from India through Greece to Arabia and to Europe, would prefer to treat Greece as the source from which India borrowed. Even if this theory should be accepted, it would not be a small achievement for India, for it would mean that the astronomers and mathematicians and men of medicine in India of those days could accept and assimilate such a volume of knowledge from a distant country like Greece. The wave of scientific interest and the application of Indian talent in the progress of science in the present times are, therefore, in accord with the ancient genius of India.

India's acknowledged political leaders also are scientific in their outlook and approach. Those who know Gandhiji intimately will see in everything that he does an uncompromising scientific attitude. He is impatient with inaccuracy and looseness of thought or inference. Even in what may appear to be unmodern in his activities, the true scientists would find in Gandhiji a brother-searcher of truth, who works with such tools as he has in strict accordance with scientific method.

The same is the case with Pandit Jawaharlal Nehru. It is not merely his position in Government that qualifies him to preside over the Delhi Session of the Indian Science Congress. His heart and his intellect throb in resonance with modern science. His taking the chair at the Science Congress and laying the Foundation-Stone of the National Physical Laboratory will give increased stimulus to original scientific research in India concurrent with political rebirth. It will be a source of inspiration and strength to all the young men in the universities who are devoting their talents to scientific studies.

Science, art and culture are not less important than politics. As long as a foreign Power had imposed its rule on us, and a struggle had to be carried on, politics had an inflated value. With freedom, things assume their real proportions. Henceforth politics will not be an obsession dominating and corrupting everything. Science as well as art and culture will be more important than Government or the controversies of politics."

SCIENCE AND INTERNATIONAL CONCORD

WELCOMING the Delegates to the 34th Session of the Indian Science Congress at Delhi, Sir Maurice Gwyer, Vice-Chancellor of the Delhi University and Chairman of the Reception Committee, said :—

"Your visit this year takes place in more than usually auspicious circumstances ; first, because this is a moment of great importance in the history of India, when the eyes of the whole country are turned towards Delhi ; and secondly, because among those who are joining in our discussions is an exceptionally distinguished body of scientists from other lands ; and for these two reasons alone the present session of the Science Congress will always be regarded as a historic event.

I am told that never before have scientists from so many foreign countries met together on the soil of India. They have come from the United Kingdom and the United States, from Canada, from Russia, from France, from China, and from Australia. This is itself a very noteworthy thing, and we in Delhi, appreciate the compliment which it implies. But above all, it is the greatest proof which could be given of the essential unity of science and of the common ground on which men of science, no matter what their race or nationality, are able to meet.

That there is a sphere in which such a common ground exists is no small thing at the present day, and we may all be grateful to the scientists for affording us so inspiring an example of international concord and co-operation. It is a happy augury that it comes to soon after the U.N.E.S.C.O. meeting in Paris, at which the delegates from India, some of whom are here to-day, took so prominent and effective a part.

We have seen in Delhi this week three gatherings of learned men, we have welcomed a Congress of Philosophers, a Congress of those engaged in the study of politics, and to-day we welcome the Science Congress, which embraces them all. All these gatherings, have for their object the pursuit of truth in one form or another ; and it might be hard to say which body finds its material the most intractable. Some might say that in the case of the science of politics truth lies at the bottom of a deeper well ; but the students of that subject do not regard this fact as presenting any insuperable obstacle to their researches. And it has been an inspiring spectacle to see gatherings of so many men searching for truth in all its many-sided aspects, not for gain or glory, but because truth is to them the most important thing in all the world.

Many of us believe that the future happiness of the world rests largely in the hands of scientists, who are the modern magicians and miracle-workers; it is not their fault that others at times pervert to ignoble uses the gifts which science gives us. It is with this in our thoughts that the University offers them its greetings and its welcome to-day."

Outlining the true function of universities, Sir Maurice declared: "I hope too that this year's meeting of the Science Congress will mark the beginning of a reorientation of the attitude of Indian universities towards scientific studies. There has been, I think, too great a pre-occupation with lectures and degrees, to the prejudice of true learning and research. None denies the importance of learning and research; but there is still room for the more complete recognition of the fact that the greatest and most vital function of a university is to increase the bounds of human knowledge, to be a centre of culture in the broadest sense, to be the guardian of fundamental values and to set the standards for its generation.

This is the true idea and conception of a university not only in India but in every land. To achieve it will be made more easy by the new attitude of the authorities here towards the universities and by the munificent grants which by a welcome change in policy they are now beginning to make.

If the assistance thus generously given is not allowed to prejudice the autonomy of the universities, for that is a precious possession which they could never yield up without being false to everything for which they stand, a future lies before us incomparably greater than anything which the universities have known in the past. They will become what they ought to be, homes for original research and for the promotion of learning, wherein a true academic atmosphere in which intrigue and jealousies have no place, men may have freedom to develop all the talents which God has given them, serving faithfully their own generation and handing on the torch undimmed to the generations which come after."

THE THEORY OF THE FISCHER-TROPSCH SYNTHESIS

By M. V. C. SASTRI

IN a contribution[1] to the Discussion on "Hydrocarbon Chemistry", held in 1939 by the Faraday Society, London, Dr. S. R. Craxford of the Fuel Research Station, Greenwich, put forward a theory of the Fischer-Tropsch synthesis, depicting the formation of long chain hydrocarbons in essentially three stages, namely: (1) the formation of a carbide-surface (usually cobalt carbide), (2) the limited reduction of the carbide to form long chains of $-CH_2$ groups on the surface, and (3) the disruptive reduction of the CH_2 chains with chemisorbed hydrogen atoms to yield hydrocarbons of suitable molecular weights:

$$(1)\quad 2\,Co + CO + H_2 = Co_2C + H_2O$$

$$(2)\quad H_2 + Co_2C = 2\,Co + {}^{\downarrow}CH_2{}_{\downarrow}$$

$$(3)\quad \ldots C-CH_2-(CH_2)_x-CH_2-C\ldots + 2H = CH_3(CH_2)_x\,CH_3$$

This mechanism has been successful in accounting for most of the phenomena connected with the Fischer-Tropsch synthesis.[1,2] By employing the *ortho-para* hydrogen conversion as a tracer reaction for ascertaining the presence of chemisorbed hydrogen atoms, it was shown that oil formation proceeded only when the surface was almost completely covered by carbide. In the presence of chemisorbed hydrogen, methane was the chief product. Carbide-free surface also facilitated the water-gas-shift reaction

$$(4)\quad CO + H_2O = CO_2 + H_2$$

which accounts for most of the carbon dioxide formed and is obviously an unnecessary side-reaction.

A plentiful accumulation of carbide-centres on the surface of the catalyst is, therefore, essential for maximum yield of oil and this is actually what happens during the so-called "running in" process, in which the freshly reduced catalyst is given a prolonged preliminary treatment with synthesis gas at below the reaction temperature. The importance of the surface-carbide has received further emphasis in two recent papers of Dr. Craxford published by the Faraday Society. In the first paper,[3] it is demonstrated that as the rate of passing the synthesis gas over the catalyst bed is increased the yield of oil passes through a sharp maximum. Simultaneously, the amount of carbon dioxide formed drops abruptly as the velocity is increased beyond the value required for maximum yield of oil. The explanation given is that at low gas-rates oil-synthesis is nearly completed over the first part of the catalyst bed, leaving the succeeding parts free from carbide and, therefore, able to promote the formation of methane and carbon dioxide. At the optimum gas-rate there is obtained a uniform distribution of carbide centres and the whole of the catalyst is thus actively engaged in oil-formation. At higher gas-rates the yield of oil naturally falls off rapidly due to the time of contact with the catalyst surface being too short. With continued use, the catalyst deteriorates, presumably as a result of wax-formation and carbon-deposition, so that the surface available for the synthesis and the side reactions alike dwindles continuously. In consequence, the length of the catalyst bed required for good yield of oil becomes greater and greater and the position of the optimum gas-rate shifts in the direction of lower values. This explains why, if the gas-rate is maintained at a steady value below the initial optimum, the yield of oil at first rises to a peak value after a few days' use and then falls off slowly—a result which is quite familiar to experimenters in this field and which is often reported mistakenly as the "rise and fall in the activity of the catalyst". The advantage of conducting the process in stages can also be appreciated in the light of the carbide theory.

In the second paper,[4] the function of the promoters, thoria and kieselguhr, has been examined by kinetic measurements. The results emphasise the salient fact that although the primary consideration for an active Fischer catalyst is a high rate of carbide-formation, this must be coupled with a relatively slow rate of reduction of the carbide in order that oils and not gases may be produced. A catalyst containing cobalt with 18 per cent. thoria and no kieselguhr, in spite of its high rate of carbide formation, is rendered unsuitable by an excessive rate of reduction. On the other hand, a catalyst containing cobalt with 21 per cent. thoria and 100 per cent. kieselguhr is poor in both respects, slow carbidisation and fast reduction. The catalyst commonly used containing cobalt with 18 per cent. thoria and 100 per cent. kieselguhr has a relatively rapid carbide formation which, together with slow reduction, accounts for good yields of oil.

The emphasis placed so strongly on the importance of surface-carbides should not obscure the equally important role of chemisorbed hydrogen atoms which, though relatively few in number, are no less vital to the formation of oil. The fragmentation of the giant chains of $-CH_2$ groups chemisorbed on the surface into hydrocarbon molecules of suitable size is due to attack by these hydrogen atoms, as shown in reaction (3) above. Lack of chemisorbed hydrogen would result in the formation of waxes of indefinitely large molecular weight, with consequent deterioration of the catalyst, while an excess of it would lead to gaseous products.

The importance of chemisorbed hydrogen in the Fischer-Tropsch synthesis has been brought out more eloquently by the recent work of Sir J. C. Ghosh at the Indian Institute of Science, Bangalore. By incorporating 4 to 5 per cent. of chromium oxide in a typical cobalt-thoria-kieselguhr catalyst, very good yields of oil have been obtained, using water-gas as such without the usual addition of hydrogen.[5] The gain in economy that accrues from this development is obvious. Chromium oxide is a powerful chemisorbent for hydrogen and acts presumably as a "surface-enricher" for hydrogen, helping to maintain the necessary concentration of active hydrogen at the seat of the reaction, while at the same time allowing a higher partial pressure of carbon monoxide in the gas-phase. That this is so in fact is borne out by adsorption measurements.

1. Craxford, S. R., *Trans. Faraday Soc.*, 1939, **35**, 946. 2. Herrington E. F. G., and Woolward, L. A., *ibid.*, p. 958. 3. —, *ibid.*, 1940, **42**, 576. 4. —, *ibid.*, p. 540. 5. Ghosh, J. C., and Sastry, S. L., *Nature*, 1945, **156**, 506.

COCONUT SHELLS AS AN INDUSTRIAL RAW MATERIAL
IV. COCONUT SHELL CHARCOAL: (B) ACTIVATED CARBON

By Dr. REGINALD CHILD

(Director, Coconut Research Scheme, Ceylon)

THE first part[67] of this the fourth article of the series dealt with Coconut Shell Charcoal so far as concerned the preparation of the crude (primary) charcoal and some of its uses. Only brief reference was made to its principal application as "activated carbon".

A general account of activated carbon is not here possible. What is attempted is a discussion of the position coconut shell charcoal occupies in this field. References to the more important published reviews of the general subject are given.[68–76]

The power of freshly made wood charcoal to absorb gases was certainly known in the late eighteenth century, as was its property of removing colouring matter and impurities from solutions. The volumes of different gases absorbed by a unit volume of charcoal were measured by Th. de Saussure[77] (1814) and his figures are still quoted, often without acknowledgement or any indication of their date.[77a] It was known, too, that charcoals from different woods varied considerably in their absorptive capacity (*cf.* Brande, 1821)[78]

The superiority of coconut shell charcoal was established by J. Hunter, who published between 1863 and 1872 a series of papers[79] on the absorption of gases and vapours by charcoal. Since then it has been utilised in many researches, both academic and applied. Dewar observed the extraordinary absorptive power of coconut charcoal at low temperatures and applied this property to the production of high vacua and the separation of gases.[80] Rutherford used the same method in his work on radium emanation and J. J. Thomson testified that Dewar's method of exhaustion by strongly cooled charcoal had been almost a main contributory cause to the progress of modern physics.[81]

Although it is only since the war of 1914-18 that activated carbons have been widely developed industrially, there were prior to this a number of scattered observations on "activation". Thus de Saussure's boxwood charcoal samples were heated to redness and cooled under mercury before each absorption measurement. De Bussy[82] in 1827 described several methods of increasing the decolorizing power of vegetable charcoals. An early example of "chemical activation", using metal chlorides, is that of Ostrejko (1900).[83] Halse (1903) similarly employed sulphuric acid.[84] Dewar's coconut charcoal was steam activated; an interesting discussion of the nature of Dewar's charcoal has been given by Hassler *et al.* (1939).[85]

Reference has been made in the previous article[67,49] to the developments in 1914-18, when active carbons were required for gas masks. Accounts of the work of the U.S. Chemical Warfare Service were published in 1919 by Dorsey[86] and by Lamb *et al.*[87] Preliminary experiments had shown that the activity of charcoal increased with the apparent

density of the raw material; of fifty or more materials investigated, coconut shells had the highest density and gave the most active charcoal. As supplies of coconut shells were limited by transport difficulties other raw materials were also used in practice, including various nut materials such as cohune nuts, cherry stones, apricot stones and vegetable ivory, and (later) anthracite coal. These papers carry photomicrographs of interest including some of coconut shell, primary charcoal and charcoal at various stages of activation.

It was briefly mentioned in the previous article[67] that preliminary investigations had been carried out in coconut-producing countries on the possible local production of active carbons. In the Philippines the subject was studied, especially by Clemente and his colleagues at the University. In 1930[88] experimental results were published on the relative adsorption of acids and bases from aqueous solution by forty-one different kinds of Philippine wood charcoal (not chemically treated). Coconut shell charcoal had the highest adsorption for potassium hydroxide and the lowest for hydrochloric and acetic acids. Decolorizing charcoals were prepared by Clemente and Pascual (1939)[89] from coconut shells, husks and cake, by impregnating with zinc chloride and carbonizing. Tested by their adsorption of Sudan III from kerosene and methylene blue from aqueous solution they were about as active as Norit. Charcoal prepared by other treatments were less effective. Clemente and Galang[90] prepared active charcoals by the zinc chloride method from various agricultural by-products, including coconut shells, and compared their adsorption of methylene blue, Congo red, methyl-violet and iodine from aqueous solutions and of colour from coconut oil; the adsorptive properties of these charcoals for vapours of ether, benzene, alcohol and chloroform were also studied.[91] Similar work was reported by Samaniego and de Leon (1940),[92] who prepared charcoals activated in various ways from rice bran, rice hulls, coconut shells, corn-cobs, lumbang* (candlenut) shells and pilinut† shells. The best decolorizing carbon, as estimated by its adsorption of iodine, was coconut shell charcoal prepared by impregnating with phosphoric acid; satisfactory gas adsorbents were obtained from all three nut shells impregnated with caustic soda. It was stated in 1939[50] that there was then no commercial production in the Phillipines of activated carbon from coconut shell charcoal. The "Cochar" Products Inc., were, however, stated to be ready to undertake production if a market could be found; the Company were understood to have patented a process utilizing the combustible gases from the primary carbonization to make the activated carbon (see below).

Rao in India (1939)[93] studied various raw materials, including coconut shells, as sources of active charcoal suitable for sugar refining. Satisfactory gas adsorbent charcoal was prepared by Neubauer and Rands[94] in New Zealand by steam activation of crude coconut charcoal from Samoa. Similar laboratory scale work is believed to have been carried out by the Department of Commerce and Industries in Ceylon but nothing has been published.

Methods of Preparation

Methods of preparation of decolorizing carbons have been classified by Mantell (*loc. cit.*, 1941, 1298-99) as follows:—

Class 1.—Carbon is deposited on a porous inorganic base to produce materials analogous to bone chars. Natural high-ash products such as rice hulls, which contain an appreciable amount of silica, may be used directly as raw material (*cf.* Clemente's work in the Philippines). Vegetable materials such as saw-dust, sea-weed, bagasse, etc., may be mixed with porous substances such as pumice or diatomite; the mixture is strongly heated whereby the carbon is deposited throughout the porous base.

Class 2. Impregnation Methods.—Suitable carbonizible materials are impregnated with chemical reagents such as sulphuric acid, phosphoric acid, metallic (especially zinc) chlorides, etc; after carbonization at comparatively low temperatures, the resultant carbons are washed free from inorganic compounds. A second carbonization is sometimes given.

Class 3.—Primary charcoals are prepared by heating suitable materials (wood, lignite, waste sulphite liquors, etc.) in retorts. The properties of the final carbons vary considerably with the conditions of carbonization. The primary charcoals are activated by air, oxides of carbon, chlorine, superheated steam, or mixtures of steam and air, the effect being one of selective removal of the residual hydrocarbons on the internal surfaces of the charcoal. When oxides of carbon are employed there may be redeposition of active carbon on the surfaces of the material undergoing activation (*cf.* the Cochar process mentioned above).

The preparation of gas-adsorbent carbons usually follows the lines of class 3. Further information on laboratory and commercial methods will be found in the references given.[68-76]

The dense hard charcoals derived from coconut and similar "nut" shells, whilst pre-eminent as gas adsorbents, are not generally so effective in decolorizing solutions, for which purpose soft and highly porous carbons are preferred. Chaney, Ray and St. John (1923)[95] attempted to correlate decolorizing and gas-adsorptive efficiencies; but there is considerable specificity in adsorptive action in liquids; a charcoal active in decolorizing one type of solution will not necessarily be equally effective in other types.

Methods of Examination

(*a*) *Gas-Adsorbent Carbons*—

Particular attention may be drawn to a useful paper by Stone and Clinton (1942).[96] The most reliable data for assessing the efficiency of gas-adsorbing carbons are:—

(1) *Service time*, which is the time required for the break through of a vapour (usually chloropicrin) under specified standard conditoins.

(2) *Adsorption Value.*—The weight of a vapour (usually carbon tetrachloride) adsorbed by a carbon under conditions of saturation.

* *Aleurites moluccana*, Willd.

† *Canarium ovatum*, Engl.

(3) *Retentivity*.—The residual weight of vapour retained under standard conditions of temperature and pressure. Stone and Clinton correlate these with the heat of wetting in *m*-xylene for coconut carbons and provide a convenient method for evaluating them on this basis.

(*b*) *Decolorizing Carbons*—

Mantell (*loc. cit.*, 1941, p. 1300) states that "in the present state of our knowledge, data regarding the action of carbons on one solution cannot be applied to a different solution, but each one to be decolorized must be tested separately. The so-called standard methods of estimation have little practical value".

Density of Activated Coconut Shell Charcoal.—The *apparent density* (gms. per ml.) is generally measured on dry samples screened between 8 and 14-mesh. Stone and Clinton (*loc. cit.*) quote a range of 0·38-0·54 for gas-adsorbing carbons derived from coconut shells.

The true density tends to a limit of 2·1[97] (graphite has s.g. 2·25).

Industrial Applications.—The dry distillation products of coconut shells form the subject of the next article projected in this series. The prospects of an industry based on coconut shell distillation depend largely on the existence of a satisfactory outlet for the charcoal.

In the past the demand for coconut shell charcoal has been for the preparation of gas-adsorbent carbons for war purposes, and there is reason to suppose that the bulk of the nearly sixty thousand tons of crude charcoal exported from Ceylon between 1937 and 1940 inclusive was so utilized. As a supplement to the table showing exports of shell charcoal from Ceylon (1933-41) which appeared in the previous article,[67] the following table gives the exports from 1942-45.

TABLE I

Exports of Coconut Shell Charcoal (crude) from Ceylon

Year	Amount Tons	Value Rs.	Value per Ton Rs.
1942	2,334	111,422	47·74
1943	1,562	94,044	60·21
1944	470	29,900	63·62
1945	1	70	70·00

Industrial uses of gas-adsorbent carbons include: purifying carbon dioxide from fermentation processes; purifying air; solvent recovery in extraction and similar plants; recovery of gasoline from natural gas and benzene from coal gas; and in vacuum work, *e.g.*, manufacture of radio valves, X-ray tubes, etc.

Decolorizing carbons are used in water purification, refining of edible oils, and the purification of such materials as glycerine and pharmaceutical chemicals. The largest potential application is in sugar refining; the refining process using bone charcoal is very old-established, but in recent years activated vegetable carbons have been found capable of handling economically smaller outputs than the char process and involving less capital investment on equipment and buildings.

Alkali-activated charcoals can be prepared which are able to remove metals such as gold from their solutions. Avery (1908)[98] used coconut shell charcoal in an investigation of the decomposition of gold chloride in this manner.

Active carbons act as contact catalysts in a number of chemical reactions of industrial importance. Hassler (*loc. cit.*, pp. 56, 111-113) gives examples and a bibliography.

There is an extensive literature, both in technical journals and in patent records, on active carbons. This is useful on industrial applications, but less so on methods of preparation. It is probable that much information is unpublished in the records of firms actually engaged in manufacture.

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APODOUS AMPHIBIA OF THE EASTERN GHATS, SOUTH INDIA

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HERPETOLOGISTS have reported the occurrence of Apoda (Amphibia) from the Western Ghats of India, and as far as I know, there is no similar record from the Eastern Ghats.

The Western Ghats stretch from Cape Camorin to the Tapti Valley and the Palni Hills are an easterly extension of the same. Mysore and Coorg have on their western margin these Ghats from where specimens of Apoda (Ichthyophis and Gegenophis) are procured. South of Mysore, the Western and Eastern Ghats meet forming the Nilgiri Hills. The Eastern Ghats are not such a continuous stretch as the Western and extend away from the coast, from Orissa to Nellore on the east coast, the Nallamalai, Nagari and Javadi Hills and the Shevroys forming parts of this chain. The average altitude of the Eastern Ghats is about 2,000 feet.

Nagalapuram Hills (Text-Fig. 1) are isolated in the north-western corner of Tiruvallur taluq, Chingleput district, to the east of Nagari Hills extending into the Kalahasti zamindari. Kambakkam reserved forest is a part of this hill and at the foot of the Kambakkam Hill, as it is locally known, there is a forest Rest House called Thantipandal (about 340 feet above sea-level). Opposite the hut, is a small pool of water near which a well-grown specimen of *Ichthyophis monochrous* (Bleek.) was collected by me. However, there was a white patch, behind the eyes, running from one side of the head to the other which is not present in specimens from the Western Ghats.

About four furlongs from the hut, there is a Dry Cow Salvage Station, instituted by the Madras Government, and opposite this is a brook which supplies water to the station.

FIG. 1. Map of Kambakkam reserved forest area (after Survey of India map nr. 57-0 /ne) in Nagalapuram Hills, Eastern Ghats.

The stream was diverted and the loose soil overgrown with grass was pulled out and a number of larvæ of *Ichthyophis monochrous* secured. It is interesting to note that these animals breed even during cold months also.

Dr. F. H. Gravely who was the first to collect two apodan specimens from Kambakkam locality sent them to America and I learn that they are still unidentified. In his letter, Dr. Gravely

stated that the specimens were secured "from under a dead log beside the mountain stream at Kambakkam in the valley between its fall from a higher altitude to low level and the canebrake near Tantipandal. If I remember rightly it was not much below the fall". The area to which Dr. Gravely refers is away in the jungle from where I collected. I showed my specimens to him but he was unable to say whether his resembled mine.

These primitive Amphibia have hitherto been unknown from the Eastern Ghats and no description of the larvæ of *I. monochrous* exists. The available literature shows that the larvæ of both *I. glutinosus* and *I. monochrous* are mixed up in description. A comparison of the larval stages of *I. glutinosus* and *I. monochrous* shows that the latter larvæ can be easily distinguished from those of its congener.

Late embryos of *I. glutinosus* show the presence of three pairs of external gills and also a 'spiraculum' in which *two* projections are noticeable between which a single cleft opens. In the aquatic larvæ where the external gills have been absorbed, the 'spiraculum' shows the two projections with a cleft in between them. Gadow,[1] however, described correctly the structure of the 'spiraculum' as above. The yellow band, so characteristic of the species appears only after the larva has grown a little; in a larva measuring 79-80 mm. there are no bands while in that measuring 82-85 mm. the bands are just visible. However, Sarasins,[2] confirming the observations of Müller, noted *three* projections in the 'spiraculum' of *glutinosus* corresponding with the second, third and fourth ceratobranchials, and two gill slits between the second and the third and the third and fourth arches respectively. In his descriptions of early larval stages of *glutinosus*, Deraniyagala[3] noticed that in a larva measuring 94-96 mm. each 'spiraculum' disclosed three vestigial branchial arches and he delineated three projections in the 'spiraculum' in his Figs. 1 and 2 (Plate XXXVII). In a stage which he characterised as the next during metamorphosis of this species ('terrestrial larva', 157 mm. long) he recorded that the 'spiraculum' showed only *two* vestigial branchial arches but no reference has been made to the number of slits either in this or in his previous 'aquatic' larval stage.

Boulenger[4] in describing the systematics of Apoda, draws figures of the larvæ of *I. monochrous* (Pl. IV, Fig. 1-1c); in the profile of the head, the figure seems to show only two projections in the 'spiraculum' and the exact number of annuli intercepted by the anus could not be made out in Fig. 1c.

In a sectional view of a larva described as belonging to *I. glutinosus*, Norris and Hughes[5] show the second gill slit passing evidently between the third and fourth branchial arches since a portion of the fourth branchial arch is also depicted. These authors are also describing a larva with two pairs of gill slits.

Since the yellow bands are not formed in the early larvæ of *I. glutinosus*, it is possible that the collections of Sarasins and of Deraniyagala contain larval forms of both species of *Ichthyophis* which could not thus be differentiated and the latter author has, therefore, regarded those with three projections as an earlier aquatic larval stage of *glutinosus*. Further, while Sarasins show three projections in some figures (Pl. XXIV, Figs. 119, 120) and sectional views (Figs. 121, 122), only two plate-like structures are depicted in Figs. 48 and 51 (Pl. V); obviously the collection is a mixed one.

After examining a closely graded series of embryos (egg clusters with mothers) and larvæ of *I. glutinosus* from Kotgehar (Mysore State) and having sectioned stages earlier than those studied by Deraniyagala, I am unable to corroborate the observations of Sarasins and of Deraniyagala with regard to the number of projections and slits.

The characters of the larvæ of *Ichthyophis monochrous* and *Ichthyophis glutinosus* can now be described as follows:—

I. monochrous (Bleeker): Larva studied 200 mm. in length with a very prominent tail fin, the dorsal lobe of which extends in front of the anus; snout length less than the interorbit; no yellow bands, a uniform steel blue; head shows thick lips, two milky eyes with a tentacular orifice in front of each eye (even in a larva measuring 100 mm., the smallest that I possess, this orifice is present); sensory openings on the head; 322-325 rings on the body; the cloacal opening interrupts seven annuli; eight postanal annuli and a small posterior

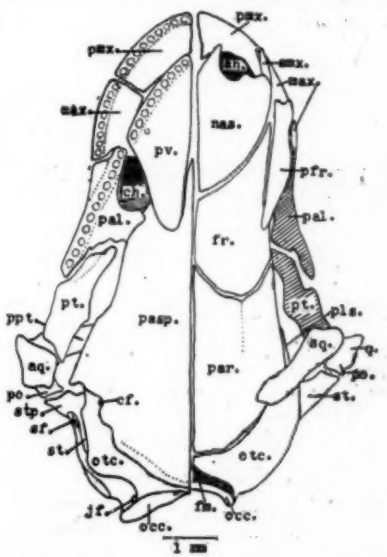

FIG. 2. Skull of a larva of *Ichthyophis monochrous* (Pleek.) (ventral aspect on left side).

an., anterior naris; *aq.*, articular facet of quadrate; *cf.*, carotid foramen; *ch.*, choana; *fm.*, foramen magnum; *fr.*, frontal; *jf.*, jugular foramen; *mx.*, maxilla; *nas.*, nasal; *occ.*, occipital condyle; *otc.*, otic capsule; *pal.*, palatine; *par.*, parietal; *pasp.*, parasphenoid; *pfr.* prefrontal; *pls.*, pleurosphenoid; *pmx.*, premaxilla; *po.*, processus oticus; *ppt.*, processus pterygoideus; *pt.*, pterygoid; *pv.*, prevomer; *q.*, quadrate.

portion; 'spiraculum' with *three* projections and *two* clefts in between; a mucus pit, in some, in front of the 'spiraculum'; scales in the dermis. The skull (Text-Fig. 2) shows a temporal gap on account of the incomplete growth of the squamosal (*sq.*); a post-frontal is wanting; palatine (*pal.*) separate from maxilla (*max.*); palatine teeth 11, maxillary 8, prevomerine 9 and premaxillary 9; the maxillary and palatine teeth rows are unequal, the latter extending behind the choana more than the former; the lower jaw carries two rows of teeth, the inner row short; the stapedial artery pierces the columella (*sf.*); the ceratohyals and the first two pairs of ceratobranchials are connected mesially by basihyal and copula 1 and 2 respectively; the fourth ceratobranchial is small and articulates at the middle of the third ceratobranchial; the gill clefts are between the second and the third and the third and fourth arches respectively.

I. glutinosus (Linné): Larva studied 130 mm. long with a tail fin shorter than in *monochrous* and with a dorsal lobe as in *monochrous*; snout length more than the interorbit; yellow bands on the sides extending from the sides of the head; head shows two eyes with a tentacular orifice in front of each eye, but in a larva measuring 101 mm. this orifice is not yet formed; sensory openings on the head; the cloacal opening interrupts five annuli; 3-4 postanal annuli and a short postanal portion; 'spiraculum' shows only *two* projections with a cleft between them.

The skull shows a temporal gap on account of the incomplete growth of the squamosal; a postfrontal wanting; palatine and maxilla separate; stapedial artery pierces the columella; the hyobranchial apparatus is as in *monochrous* and the only gill slit is noticed between the third and fourth ceratobranchials.

Thus when the yellow bands have not yet appeared in *glutinosus*, the *monochrous* larvæ can be differentiated from the former by the possession of (1) a 'spiraculum' showing three projections and two clefts and of (2) a snout shorter than the interorbit. In older larvæ, the annuli become clearer and in *monochrous*, the anus interrupts seven annuli.

I must express my sincere thanks to Dr. A. Aiyappan, Superintendent of the Government Museum, Madras, for affording facilities which enabled me to explore the Kambakkam Hills. I am also thankful to Mr. P. E. P. Deraniyagala of Ceylon for kindly going through my material and offering useful suggestions. To the authorities of the University of Mysore, I am deeply indebted for defraying the cost of two expeditions to the Kambakkam forest.

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ERADICATION OF INSECT PESTS OF STORED GRAINS RATHER THAN THEIR CONTROL*

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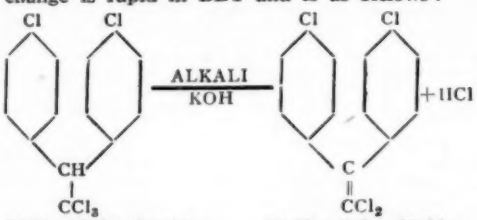
I. General

THE urgency of the need of an effective control of harmful insects was felt in the World War when every effort was directed to produce more food and to save as much as possible from the ravages of insects in order to avert the threatening world-wide food shortage. With unceasing search and never getting disappointed with their efforts in the advancement of science and perfection of the known and discovered things, the scientists were able to bring to light the spectacular insecticidal properties of the two substances, *viz.*, Dichlorodiphenyltrichloroethane and Benzenehexachloride which remained undiscovered till then. The application of these has not been perfected and still needs careful investigation. However, on the basis of whatever achievements have been affected uptil now, it can be safely predicted that the control of the agricultural crop pests is definitely going to be revolutionised and become less complicated. We hope that time is not far off when we shall claim eradication of insect plagues rather than their control. Already a good deal of contribution has been made by the scientists all over the world but the prohibitive cost and the non-availability of the insecticides have restricted their trial and use in India. Such factors are, however, considered of little importance and value when the study of the scope of a new insecticide is in progress. For instance, methyl bromide was considered to be a costly fumigant till 1938 (fumigation properties discovered in 1934-35) but its inherent valuable properties made it possible after some time to procure it at cheaper and economical price, thereby helping in its extensive use in the present days. In India these new insecticides have been tested extensively against mosquitoes, flies, sand-flies, lice, etc. Their use in agriculture is slowly finding its way and co-ordinated attempts have so far been instituted to find out their practical application in the control of

*A simple method for the control of insect pests of stored grains and potato tuber-moth by the use of DDT and 666 has been evolved.

stored grain pests. The urgency of their use in this line was realised when it was made known to the public that the stored food-grains in India are undergoing an undetectable loss of 3·375 million tons of food, sufficient to feed 6 million persons for full one year. A meeting of all Entomologists in India was called by the Food Department, Government of India, to plan out the proper application of the chemicals (DDT and 666) in respect of combating the stored grain pests. The Entomologist from the Ordnance Laboratories, Cawnpore, while reviewing his researches about the application of the insecticides as debris disinfectants and in whitewash† for disinfecting godowns, put forth his interesting conclusions on whitewashing of godowns for the control of stored grain pests. These inferences were, however, identical to those of the writer arrived at independently as a result of research on similar lines at the Imperial Agricultural Research Institute, New Delhi, under the then Director, Dr. Hem Singh Pruthi. These are :—

(1) Lime inactivates the two insecticides causing dehydrohalogenation. The chemical change is rapid in DDT and is as follows :



Dichlorodiphenyltrichloro-ethane *Dichlorodiphenyldichloro-ethylene*

(2) Chalk, although a neutral substance, has got the limitations of being costly and not easily available. Further it does not form a good wash.

(3) The particles of chalk and lime cover to a considerable degree the minute particles of DDT and 666, never allowing the covered particles to play their role.

(4) Particle size plays fundamental part in case of all nerve poisons. The most effective size is 5 microns. This much size of the particles can be obtained on evaporation of the solvent from the solution or emulsion.

It is, therefore, quite evident from the above that the whitewashing experiments would be of little use for the chances of killing insects to an appreciable degree are remote. The only possibility for the application of these insecticides on the walls is to apply them as spray in petrol, kerosin oil, etc. The writer consequently considered it worthwhile to give up the idea of pursuing the whitewashing treatment. To support the contention further, it may be added that few insects crawl on the walls of a godown packed with bags of grains unless the grains are disturbed, the temperature is very high, the insects are in enormously large numbers or the percentage of infestation exceeds fifty. Some of the conditions enumerated above appear at a stage when grains become totally unfit for consumption thereby rendering the treatment of little use, while the remaining ones that occur occasionally are difficult to secure. Hence again the utility of the treatment is not encouraging. It may, however, be mentioned at this stage that whitewashing could be employed for disinfection of empty godowns where insect-free produce is likely to be stored. The possibility of disinfection under the above conditions can be ruled out to some extent for it is easy to disinfect by sulphur fumes or HCN, this treatment will not only be convenient but effective also. However, with all the points unpropitious whitewashing may be adopted for treating underground godowns or *khattis*, where fumigation is a problem. But seldom there is necessity of disinfecting an improvised bin as the damage in it is always negligible. Here too, the spraying of a solution or emulsion would be advisable.

The writer thus restricted his attempts in finding out an easy method by which an attack of insects to sound and healthy grains may be warded off effectively and also infestations present to a certain degree may be eliminated with special reference to storage in bags. Holding of grains in bags is convenient and hence unavoidable and indispensable although unfortunately the damage due to insects is considerable because of the easy access of the pests. The experiments together with the inferences are set forth in the following pages.

II. Experiments

Gunny bags, half of the standard size, were treated with the following solutions and emulsions of DDT and 666.

(1) *Seven, 14 and 28 per cent. mixtures in Kerosin oil.*—100 c.c. of each mixture was used for treating inner and outer surfaces of four bags.

(2) *0·35, 0·7 and 1·4 per cent. mixtures in water.*—2000 c.c. of the preparation was used to soak four bags. The poisons were first diluted with chalk so as to remove their stickiness and also to help in their uniform dispersion.

(3) *Kerosin oil emulsion containing 0·35, 0·7 and 1·4 per cent. poisons.*—2000 c.c. of the preparation was utilised in treating four bags. Kerosin oil emulsion was prepared by using gum as emulsifier.

(4) *DDT and 666 emulsions*‡ were prepared as follows : DDT or 666 25 gms., Toluene or Benzene 33·35 gms., Turpentine 33·35 gms., Water 0·6 gms., Soap 2·8 gms. Alcohol 4·9 gms. The stock solution was first diluted with four times water and then the whole quantity made upto 7000 c.c. Only 2000 c.c. of the emulsion thus prepared was used in treating four bags only.

In all there were 22 treatments and one control. Each treatment was replicated four times. The minimum dose tried was 1·7 gms. of the poisons per bag. The bags were treated on 24|25-3-1945 and then thoroughly dried up in shade. Five seers of insect-free jowar (*Andropogon sorghum*) grains were put in each

† DDT and 666 were used in white wash at the rate of 2·5, 5·0, 10·0 and 15·0 mgrms. per sq. ft.

‡ This treatment was done in August when the ready material was made available by the Director, Malarial Institute, Delhi.

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bag on 31-3-1945 and kept in a godown heavily infested with all the species of insect pests of stored grains by keeping infested grains in corners. The control lots were kept away at a distance of more than five feet from the treated ones. Two more treatments were added after a lapse of one month where DDT and 666 carried in chalk were mixed with grains at the rate of 1 in 10,000. On 16-4-1945, 25 adults of each *Sitophilus oryzæ* Linn., *Rhizopertha dominica* Fab., *Tribolium castaneum* Hbst., *Corcyra cephalonica* Staint., *Sitotroga cerealella* Oliv., and *Latheticus oryzæ* Waterh., were introduced in one replication of each treatment. The observations were taken fortnightly till the 15th of May and later on after a lapse of full one month.

III. Results

Record of the sweepings are given below in a tabular form :—

Date of observation	Sweeping from the area where treated bags were kept								Sweepings from the area of control lots
	Wt. of dead insects in grams	Percentage of insects in the sweepings (by number)							
		S.o.	R.d.	T.c.	L.o	S.c.	L.s.	Misc.	Wt. of dead insects in grms.
16 4-1945	9·2	58·0	3·4	6·3	12·6	12·5	4·1	3·1	0
30-4-1945	15·3	59·1	4·7	15·2	8·6	11·2	0·1	1·1	0·2
15-5-1945	24·35	27·6	5·1	20·4	8·1	2·1	33·6	3·1	0
30-5-1945	21·5	14·1	11·1	36·0	14·7	3·2	13·8	7·1	0·1
30-6-1945	15·6	6·8	22·4	28·5	20·2	5·6	12·3	4·2	0
30-7-1945	7·5	2·1	30·5	23·7	16·3	12·5	4·1	10·8	0
30-8-194	5·3	0·2	62·1	14·3	11·4	10·2	0·5	1·3	0
30-9-1945	2·4	—	—	—	—	—	—	—	0

(S.o.—*Sitophilus oryzæ* ; R.d.—*Rhizopertha dominica* ; T.c.—*Tribolium castaneum* ; L.o.—*Latheticus oryzæ* S.c.—*Sitotroga cerealella* ; L.s.—*Læmophlæus* spp. ; Misc.—*Corcyra cephalonica*, *Silvanus surinamensis*, *Alphitobius* sp., etc.)

In a couple of days after putting the bags in the godown, it was observed that the insects were dying in large numbers on and in the vicinity of each bag of the treated lot. A good number of insects were seen in a state of paresis and the peculiar effect of DDT or 666 causing the stretching of wings and legs as a result of nerve poisoning was also noticed in all the dead and paralysed adults. It will be seen from the above table that the mortality percentage increased immediately but declined slowly till the end of September when very few insects died. On examining the heap of infested grains (used as a source of infestation for the room), it was observed that practically the infestation was nil as compared to the one in March on account of regular drain of insects to the experimental lots.

On 15-10-1945, the grains in each bag were weighed and examined for percentage of infestation. It was interesting to note that no living or dead insect could be collected from the treated lots. Even in case of those bags where insects were actually introduced for the sake of infestation in the grains neither the damage nor any living insect could be observed. Similar observations were recorded in replications where the poisons were used as preservatives, but here the number of dead insects inside the bags was very large. Examinations of the control lots on the other hand revealed that they were full of living insects and the grains had suffered heavily to an extent of 50-70 per cent.

For further confirmation of observations as regards the annulling of development where infestations were made in the bags, some insects numbering 50, each of *Sitophilus oryzæ*, *Rhizopertha dominica*, *Tribolium castaneum*, *Corcyra cephalonica* and *Sitotroga cerealella* were caged in dishes, size 4" × 2", containing grains over DDT or 666 powder put in similar dishes, separating the two dishes by means of muslin cloth. The insects were not allowed to come in direct contact with the poisons. It was observed that all the insects died in 7-14 days' time whereas in the control lots they lived on without mortality.

It is, therefore, evident from above that DDT and 666 give out vapours which also kill insects ; hence both the poisons appear to act as contact poisons as well as slow fumigants.

IV. Discussion

It is established that DDT and 666 would be of little use in whitewash where the intention is to reduce infestations by warding off insect attack. From the foregoing experiments and results, it is evident that if bags are treated with these poisons, grains remain safe not only from the outside infestations but the infestations already present can also be annulled as the poisons act as slow fumigants as well. Of all the treatments, the application of kerosin oil mixture is easy to perform and yields promising results. It was found out by experience that while treating bags more attention is required to be directed at corners and sewn areas which appear to be vulnerable points. The least dose tried was 1·7 gms. per half the size of a standard bag, *i.e.*, 3·4 gms. per bag which remains effective for 6 months and it has been learnt that the effectiveness persists almost unimpaired even after a lapse of full twelve months. The cost of the treatment works out at 2·1 annas per bag and this figure is very low in comparison to the average loss (Re. 1 per bag of grains) sustained through insects. The cost can be further reduced by experimenting with low doses and correlating them with period for effectiveness. The other treatments have got a disadvantage of entailing extra four or five days because of drying of individual bags but are useful in not leaving any undesirable smell. In this respect

insecticides dissolved in petrol, benzene, etc., would be better if applied with a spray pump. However, it rests with individual convenience as to which treatment can be employed but it would be advisable if only one treatment is followed universally. The suggested treatment as it stands, appears to entail a huge amount of labour, etc., and will be difficult to practise in all channels of grain movements because of the conservativeness unless some law is enacted to force people to undertake the treatment. The movements of bags which are indispensable in trade, is the factor that renders this treatment complicated.

To simplify and make the treatment attractive by removing the possible shortcomings, it can, however, be suggested for transience that big sheets of gunny cloth may be treated and used as cover for individual stacks. These sheets should also be spread under each stack so as to eliminate access of insects through creeping along the floor. This type of modification in the treatment is bound to be equally effective, especially in case of insect infestations in grains lying in open heaps in a godown or *khatti*. The scope of this treatment can be extended over receptacles like *dholi, bokhari, kothi*, etc. In such receptacles generally the top layers get infested and these can be easily protected by using a cover of treated gunny cloth. As an additional precaution, an extra sheet can be kept at a distance of four inches below the top, this will add to the efficiency of the treatment. In the Punjab and some other parts of India where *theka, theki, palla, palli*, etc., prepared out of gunny cloth, are in vogue to store 20-200 maunds of grains, the application of poisons as suggested in this paper, can be advocated with advantage. For rendering godowns immune to insect access, barriers of treated gunny cloth can be put on windows and ventilators and further doors and gates can be provided with curtains of the some; the use of fine wire-gauge can thus be eliminated. Spraying DDT or 666 emulsion inside godowns will further add to security against insect ravages.

Spreading of treated gunny over grain heaps appears to work nicely against *khapra*. In laboratory trials, *khapra* grubs have been found very resistant to the poisons but their beetles are very susceptible.

It may also be indicated that by adoption of this treatment, i.e., use of treated gunny cloth, there will be a great relief from the nuisance of potato tuber moth, *Gnorischema operculella* and bruchids. Only a thin gunny cloth as a cover will suffice for an effective control. A trial on a small scale was conducted at the Imperial Agricultural Research Institute, New Delhi, and encouraging results were obtained.

The application of DDT and 666 presented in the paper has given marvellous results in the control of a number of pests and needs further investigations as to its scope against similar insects. It is also suggested that the findings contained in this paper may be tested on a large scale keeping at least 200-400 bags in a test, in places where facilities exist, *e.g.*, at Government Farms and results watched for full one season. The following different treatments can be included in the proposed trial:

(1) Treated gunny bags only.
(2) Treated gunny bags covered with treated gunny cloth.
(3) Untreated gunny bags covered with treated gunny cloth.
(4) Godowns provided with treated cloth barriers at windows, ventilators and doors.
(5) Spraying of walls with DDT or 666 emulsion.

The author is confident that if due attention is paid to develop the suggested line of action there is no reason why we should not claim eradication of certain pests. However, at present the seed storage and the bulk storage as well appear to become simple and efficient against insect plagues.

V. Conclusions

Pursuing of experiments with DDT or 666 in whitewash appears to be of little advantage. Spraying of emulsions or solutions of DDT or 666 is better substitute for white-washing of godowns where the object is to provide an inimical surface to pests of stored grains.

DDT and 666 act as slow fumigants also; this property helps in dealing away with small infestations present in bags or storage receptacles.

Infestations of stored grain pests can be easily and efficiently eliminated by the use of bags treated with emulsion or solution of DDT or 666. Treated gunny cloth can be employed as cover for stack of bags with equally good results in case the bag treatment is inconvenient to practise.

The scope of the proposed application of DDT and 666 can be intelligently extended over to grains stored in various receptacles in vogue.

Barriers of treated gunny cloth can be put on doors, windows and ventilators of a godown thereby eliminating the use of fine wire-gauze.

Troubles of potato tuber moth are easily remedied by merely covering stored potatoes with a treated gunny cloth.

VI. Acknowledgments

The author acknowledges with gratitude the kind interest taken by Dr. H. S. Pruthi, O.B.E., the then Director of I.A.R.I.; he gladly tenders his thanks to Dr. Taskhir Ahmad, Second Entomologist in-charge of the Division of Entomology, for advice and affording necessary facilities and also to Mr. Manzoor Ahmad for help in carrying out the experiments. Finally, he records his indebtedness to the Imperial Council of Agricultural Research, which financed the scheme for research on insect pests of stored jowar, under which this additional work was carried out in leisure hours.

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1. Mackie, D. B., "Methyl bromide–its expectancy as a fumigant," *Jour. Econ. Ent.*, 1938, **31**, 70–79. 2. Nasir, M. M. "DDT, 666 and Insect Pests of Stored Grains," *Curr. Sci.*, 1946, **4**, 98–99. 3. Nasir, M. M., and Manzoor, A., *Jowar. Its Pests and Storage*, in press. 4. Pruthi, H. S., and Nasir, M. M., "Tests with DDT and 666 as Agricultural Insecticides in India—I. For stored grains," *Indian Farming*, 1945 **6**, (2), 506–10.

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DIRECTION OF MOVEMENT OF TROPICAL CYCLONIC STORMS

By S. L. MALURKAR

(*Poona*)

THE movement of a cyclonic storm is of great importance for a forecaster, and to the general public as those who experience the effects of the weather. It is well known that the direction of movement of an extra-tropical cyclone is determined by the cirrus or 6 km. winds in the warm sector or the sector containing the maritime air. Many attempts have been made to find out if similar general rules are likely in the case of tropical disturbances. A systematic attempt was made to study tropical weather and several useful deductions derived.* Taking all salient facts into consideration, it is suggested that a useful rule would be: that *the movement of a tropical cyclonic storm is determined by the higher level air motion corresponding to the sector containing the "energy source" air mass.*

It has been stated that the general sweep of 4, 6 and 8 km. winds gives an approximate direction of motion of the tropical cyclonic storm (p. 46). It has been pointed out (pp. 34-43 and pp. 87-92) that both in the case of monsoon depressions and tropical cyclonic storms, one has to consider the advent of three air masses. Due to various factors and the regions of travel, these air masses cannot be distinguished by the differences of temperature alone. Some characteristics, like the diurnal variation of temperature, content of moisture and degree of inherent instability (latent instability?) have been pointed out as the distinguishing characteristics of the different air masses. The three air masses that go to form the tropical depressions are:

(1) *Equatorial Maritime Air*—which has crossed the equator as a "pulse", from the south to the northern hemisphere and from the north for the southern hemisphere. It has large moisture content and can be made easily unstable and give rise to thunderstorms.

(2) *Transitional Air* (containing mixture of tropical maritime and tropical continental air in varying proportions corresponding to the season and region of the country)—reaching the depression in Indian lattitudes from the far-east, the ultimate origin being the Pacific high.

(3) *Continental Air* (mostly tropical with an occasional slight mixture of Polar continental) reaching Indian area from a north-westerly or westerly direction. The air is dry and is hotter in summer and colder in winter on the surface than the other air masses.

Without the existence of the three air masses, the formation of a monsoon depression or a tropical cyclonic storm is not possible, only a low pressure wave, which travels faster across the country than the depression, results.

In the extra-tropical depressions there are only two air masses involved: one maritime (tropical) and the other continental (tropical or polar in varying proportions depending on the season and locality).

The tropical cyclonic storm recurves towards an easterly direction if it reaches a sufficiently northerly latitude in the northern hemisphere and a southerly latitude in the southern hemisphere. It has been pointed out (p. 100 A and Addendum to p. 47) that it is possible to locate on an extended chart an extra-tropical cyclone or disturbance under whose influence the tropical cyclonic storm apparently recurved.

It is also well known that a tropical cyclonic storm after recurvature and entering the temperate lattitudes has the character of an extra-tropical depression (after Bjerknes). The upper air wind at about 6 km. in the lattitudes nearer the equator (in the regions where the depressions form and in the seasons when they form) are easterly and in the latitudes further away westerly

The tropical cyclonic storm, as a tropical cyclonic storm, fills up soon after the supply of the fresh equatorial maritime air is cut off, due to the formation of a fully formed tropical depression on the other side of the equator. Thereafter the resulting low may be influenced by a passing extra-tropical disturbance and may recurve towards the east.

All the above facts can be integrated into a single unified picture, under the folloing hypotheses:

(1) So long as the movement of the tropical cyclonic storm is some westerly direction, the cyclonic storm has all the three sectors.

(2) When the equatorial maritime air is cut off, the tropical cyclonic storm as envisaged till that time assumes a different character; it may fill up completely or under the influence of an extra-tropical disturbance may recurve towards an easterly direction and hence the recurved cyclonic storm has only two air masses (one maritime and the other continental). This, however, does not prevent its redevelopment into a cyclonic storm with three sectors if a fresh supply of equatorial maritime air reaches the depression, when the depression would once again have a westerly movement.

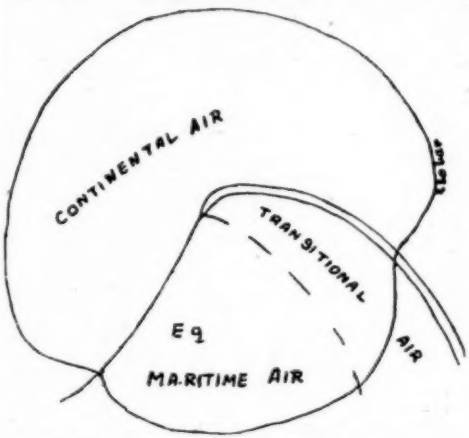
In this connection pp. 116-17 of the book referred to may be seen. The Calicut cyclone is being looked into with collaboration of Mr. P. R. Pisharothy. The cyclone moved eastwards from the S.E. Arabian Sea into the Bay of Bengal, moved in a north-westerly direction and later again recurved in an easterly direction. The speed of motion and the short life pointed to the fact that in the initial and final stages, the depression was influenced by western disturbances. As mentioned there, a secondary of a western disturbance can be destructive and show a good circulation. The several types of cyclonic storms mentioned by Deppermann* and others can also be simplified if they are divided into groups which were secondaries of extra-tropical disturbances and those that formed with all the three

* Draft Notes prepared in Feb.-March 1943 from which extracts were printed as Tech. Notes No. 1. India Met. Dept. and "Forecasting Weather in and near India" Printed limited number in May, 1945 and released in Nov. 1945. To be printed later with diagrams, tables and addenda.

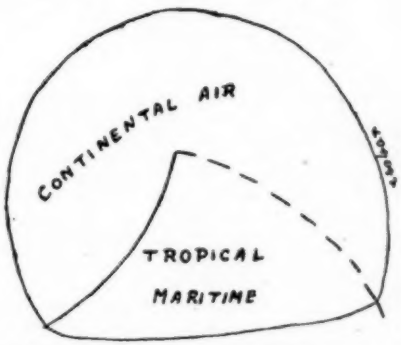
sectors and moved into China Seas. Then the same simplification as made by the author in the book and this note results.

It has been pointed also that the "source" of energy of a tropical cyclonic storm is the equatorial maritime air and the "sink" is the continental dry air or tropical continental air, and that the role of the far-eastern air is to delay the cycle of operations till sufficient vorticity is developed (the earth's rotational effect being smaller in equatorial latitudes, the time required to develop vorticity would necessarily be greater)*. In the extra-tropical depression the "source" of energy is the tropical maritime air.

In the regions where depressions form near the equator and in the seasons, the easterly and westerly winds at levels from 4 to 8 kms. are well known, and for India were worked out by H. C. Banerjee and K. R. Ramanathan.† The hypothesis and the available diagrams all show that the direction of movement of the tropical cyclonic storms is determined by the upper air in the equatorial maritime air so long as there are three air masses and by the tropical maritime air when there are only two air masses. To conclude, it follows that the air mass which acts as the energy "source" for the depression seems to control the direction of motion of the depression. The result can be generalised, as a suggestion, that even for a low pressure wave the upper air motion at about 6 kms. in the "source" air mass must determine its direction of motion in addition to all other factors that may be responsible for its movement. When a pulse moves from south of the equator to the north carrying fresh monsoon air often one finds that the surface air is northerly. But the upper air at higher levels give a west south-westerly or even southerly direction, which permits the flow of air under suitable conditions. Further work is in progress.



1. Tropical Cyclonic Storms (Northern Hemisphere)



2. Recurved Cyclone or Extratropical Depression

*Deppermann, "Are there warm sectors in Philippine Typhoons: Bureau of Printing", Manila, 1937.

†*Sc. Notes Ind. Met. Dept.* **13**, p. 21.

APPLICABILITY OF THE PLACZEK'S THEORY OF RAMAN SCATTERING AT HIGH TEMPERATURES

By Dr. K. VENKATESWARLU, D.Sc.
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THE polarisability $\alpha(q)$ of a molecule may be expanded as a series

$$\alpha(q) = \alpha_0 + \sum_j \left(\frac{\partial \alpha}{\partial q_j}\right)_0 q_j + \tfrac{1}{2} \sum_j \left(\frac{\partial^2 \alpha}{\partial q_j\, \partial q_k}\right)_0 q_j\, q_k + \ldots\ldots, \qquad (1)$$

where the suffix 0 refers to the equilibrium configuration. q_j, q_k, etc., are the various normal co-ordinates of the moleculs and a particular set of values of q_j, q_k, etc., define a configuration q of the molecule.

The first term α_0 which is independent of the nuclear vibrations is responsible for Rayleigh scattering, while the term in $\left(\frac{\partial \alpha}{\partial q_j}\right)_0$ gives rise to Raman effect. The aggregate intensities of the Stokes and the anti-Stokes Raman lines according to the Placzek's theory of Raman scattering are given by (2) and (3) respectively.

$$I_{(\nu-\nu_j)} = \frac{64\,\pi^4}{3\,c^3} (\nu-\nu_j)^4 \{4\,A^2_{1j} - 7\,B_1\} \frac{1}{1-e^{-\frac{h\nu_j}{KT}}} \qquad (2)$$

$$I_{(\nu+\nu_j)} = \frac{64\,\pi^4}{3c^3} (\nu+\nu_j)^4 \{4\,A^2_{1j} - 7\,B_{1j}\} \frac{1}{e^{\frac{h\nu_j}{KT}}-1} \qquad (3)$$

where A_{1j} and B_{1j} are the invariants of the symmetric tensor $\left(\frac{\partial \alpha}{\partial q_j}\right)_0$. The ratio of the intensity of the Stokes Raman line to that of

the corresponding anti-Stokes line is given by (4).

$$\frac{I_{(\nu-\nu_j)}}{I_{(\nu+\nu_j)}} = \left(\frac{\nu-\nu_j}{\nu+\nu_j}\right)^4 e^{\frac{h\nu_j}{KT}} \quad (4)$$

The following are the main features of the Placzek's theory of Raman scattering.

(1) The intensity of the Stokes lines increases with the increase of temperature.

(2) The intensity of the anti-Stokes lines increases more rapidly than the Stokes lines with the rise of temperature.

(3) The intensities of the Stokes and the anti-Stokes lines become very large at high temperatures and tend to meet each other at infinite intensity.

(4) The ratio of the intensities of the Stokes and the anti-Stokes lines is given by the relation $\left(\frac{\nu-\nu_j}{\nu+\nu_j}\right)^4 e^{\frac{h\nu_j}{KT}}$.

From the investigation carried out by the author, both in solids and liquids, the following observations can be made :—

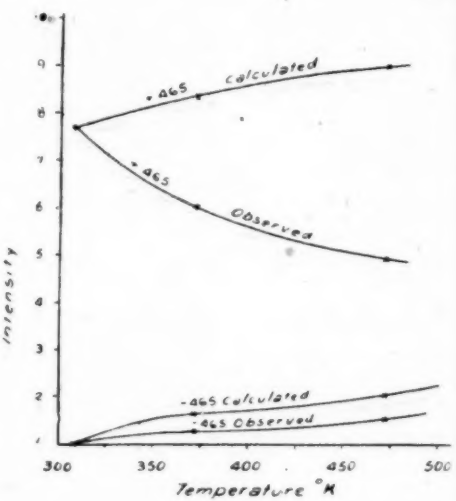
(1) The intensity of the Stokes lines decreases with the rise of temperature, the decrease in the case of calcite is more rapid for the low frequency lines.

(2) The intensity of the anti-Stokes lines, in general, increases with the increase of temperature, except in calcite, but not to the extent as is expected by the Placzek's theory.

(3) The intensities of the Stokes and the anti-Stokes lines tend to meet each other at some finite value with increasing temperature.

(4) The ratio of intensities of the Stokes and the anti-Stokes lines, at all temperatures, is in agreement with the result expected from the Placzek's theory. The ratio approaches more and more towards unity with the increase of temperature.

The observed and calculated intensities of the Stokes and anti-Stokes lines at 465 cm.$^{-1}$ in quartz, at different temperatures, are shown in Fig. 1.



One obvious criticism of the Placzek's theory is that he has taken only the first term $\left(\frac{\partial\alpha}{\partial q_j}\right)_0$ and not the higher order terms to determine the intensities of the fundamental Raman lines. The author has tried the next higher order term but has obtained the contribution of it as very small. Hence the observed result, namely, the decrease in intensity of the Stokes lines with increase of temperature, cannot be explained by taking the higher order terms also into consideration.

It can be seen from expression (2) that the inference that the Stokes lines increase in intensity with the increase of temperature is due to the exponential factor, namely, $\frac{1}{1-e^{-\frac{h\nu_j}{KT}}}$ taking the other factor as constant at all temperatures. We can take the term $\frac{64\pi^4}{3c^3}(\nu-\nu_j)^4$ as constant. The other term $(4A^2_{1j} - 7B_{Aj})$ comes out from $\left(\frac{\partial\alpha}{\partial q_j}\right)_0$ and if we take that as constant it means we are taking $\left(\frac{\partial\alpha}{\partial q_j}\right)_0$ as constant at various temperatures. The Taylor's expansion is valid only in the close vicinity of the equilibrium configuration. But as the temperature is increased the amplitudes become larger and larger and we can no longer take the Taylor's expansion, which is taken in the close neighbourhood of the equilibrium configuration, as valid. Therefore $\left(\frac{\partial\alpha}{\partial q_j}\right)_0$ cannot be taken as constant. It will decrease rapidly with the increase of the temperature. In Placzek's theory it was customarily taken as constant.

In the case of the Stokes lines, the increase due to the exponential factor is not very large but as the decrease due to the diminution in $\left(\frac{\partial\alpha}{\partial q_j}\right)_0$ with the increase of temperature is considerable, the net result will be a decrease in the intensity. For anti-Stokes lines, the increase due to the exponential factor is very large but due to the other factor it is pulled down to a certain extent, the result being an increase but not to the expected extent. In the case of calcite, the decrease in intensity of the Stokes lattice lines is very large which shows that the diminution of $\left(\frac{\partial\alpha}{\partial q_i}\right)_0$ with rise of temperature is correspondingly very large. Hence it becomes predominant in the case of the anti-Stokes lines, the result being a decrease in the intensity of the anti-Stokes lines also. The ratio of intensities of the Stokes and the anti-Stokes lines is, however, unaffected by this variation in $\left(\frac{\partial\alpha}{\partial q_i}\right)_0$ with temperature.

The author is thankful to Prof. S. Bhagavantam for the interest he has taken in this work.

LETTERS TO THE EDITOR

A GENERALISATION OF LAPLACE'S TRANSFORM

1. Transforms of the type

$$\phi(p) = p\int_0^\infty F(xp)\, f(x)\, dx$$

have long been known and the special case of this when $F(xp) \equiv e^{-xp}$ and hence

$$\phi(p) = p\int_0^\infty e^{-xp} f(x)\, dx \qquad (1)$$

has led to the subject of Operational Calculus, a powerful tool for tackling problems in Mathematical Physics and on which exists a good deal of literature. The relation (1) is known as Laplace's integral. It is possible to generalise[1] Laplacian Transform and the object of this note is to give an interesting generalisation and to introduce a new calculus based on this generalised Laplace's Transform.

2. If we take

$$F(xp) \equiv (2xp)^{-\frac{1}{2}} W_{k,m}(2xp)$$

where[2] $W_{k,m}(x)$ denotes a Whittaker Function, we obtain the transform

$$\phi_m{}^k(p) = p\int_0^\infty (2xp)^{-\frac{1}{2}} W_{k,m}(2xp)\, f(x)\, dx \qquad (2)$$

For $k = \frac{1}{2}$ and $m = \pm\frac{1}{2}$ when $(2xp)^{-\frac{1}{2}} W_{k,m}(2xp)$ degenerates into e^{-xp} we get Laplace's Transform.

We shall call $\phi_m{}^k(p)$ as the Whittaker or $W_{k,m}$—transform of $f(x)$ and $f(x)$ the original of $\phi_m{}^k(p)$ in this new transform.

In view of the involved nature of the function $(2xp)^{-\frac{1}{2}} W_{k,m}(2xp)$ as compared to the exponential function e^{-xp}, theorems based on this generalised Laplace's transform are not so easy to prove. We give, for the present, without proof, five theorems for this new Calculus.

Theorem 1A. If $\phi^k{}_m(p)$ is the Whittakar Transform of $f(x)$, then $\left(-p\frac{d}{dp}\right)^n \phi^k{}_m(p)$ is the Whittaker Transform of $\left(x\frac{d}{ix}\right)^n f(x)$.

Theorem 2A. If $\phi_m{}^k(p)$ and $\phi^{k'}{}_{m'}(p)$ are the $W_{k,m}$—and $W_{k',m'}$—transforms of $f(x)$ and $\psi(x)$ respectively, then

$$\int_0^\infty \phi^k{}_m(x)\,\psi(x)\frac{dx}{x} = \int_0^\infty \phi^{k'}{}_{m'}(x)\, f(x)\frac{dx}{x}.$$

This theorem may be considered as a Parseval Theorem in the Theory of Whittaker Transforms.

Theorem 1B. If $\phi^k{}_m(p)$ is the Whittaker transform of $f(x)$, then

$$\int_0^\infty \phi^k{}_m(x)\frac{dx}{x} = \frac{\Gamma(\frac{1}{2}-m)\,\Gamma(\frac{1}{2}+m)}{2\,\Gamma(\frac{1}{2}-k)}\ldots$$

$$2F_1\left[\begin{matrix}\frac{5}{4}+m, \frac{5}{4}-m \\ \frac{7}{4}-k\end{matrix}; \tfrac{1}{2}\right]\int_0^\infty \frac{f(x)}{x}\,dx.$$

Theorem 2B. If $\phi^k{}_m(p)$ is the Whittaker Transform of $f(x)$, and $f(p)$ is the Laplace Transform of $\psi(x)$, then

$$\phi^k{}_m(p) = \frac{\Gamma(\frac{5}{4}+m)\,\Gamma(\frac{5}{4}-m)}{4p\,\Gamma(\frac{11}{4}-m)}\times$$

$$\int_0^\infty 2F_1\left[\begin{matrix}\frac{5}{4}+m, \frac{5}{4}-m \\ \frac{11}{4}-m\end{matrix}; -\frac{s-p}{2p}\right]\psi(s)\,ds.$$

Theorem 1 C. If $\phi^k{}_m(p)$ is the Whittaker Transform of $f(x)$, then

$$\sum_{r=0}^{\infty}\frac{1}{r!}\left(\frac{1}{a}-1\right)^r \phi_m{}^{k+r}(p)$$

$$= p\,a^k\int_0^\infty (2xp)^{-\frac{1}{2}}\,e^{xp(1-a)}\,W_{k,m}(2xpa)\,f(x)\,dx.$$

3. Theorems marked A are exactly similar in form to the corresponding ones in the theory of Operational Calculus, those marked B have generalised appearances and give, as particular cases, the corresponding theorems of Operational Calculus, due to Van der Pol[3] and Humbert.[4] It is interesting to note that the Theorem 1 C has no analogue in the Ordinary Operational Calculus.

4. Special cases, besides the ordinary Laplace's Transform, of the general transform (2) may be obtained by taking particular cases of Whittaker functions. The following may be noted :

(i) K_n – transform [$K_n(x)$ denoting Bessel Functions of the second kind for imaginary arguments]

$$\phi_m{}^0(p) = (p/\sqrt{\pi})\int_0^\infty (2xp)^{\frac{1}{2}}\,K_m(xp)\,f(x)\,dx.$$

This is obtained by taking $k=0$ in (2).

(ii) $L^n{}_s$–transform [$L_s{}^n(x)$ denoting generalised Laguerre Polynomials].

$$\phi^{\frac{1}{2}+\frac{1}{2}n+s}_{\pm\frac{1}{2}n}(p) = (-)^s\,s!\,p\times$$

$$\int_0^\infty \{(2xp)^{\frac{1}{2}n+\frac{1}{4}}\,e^{-xp}\,L^n{}_s(2xp)\}\,f(x)\,dx.$$

This is obtained by taking $k=\frac{1}{4}+\frac{1}{2}n+s$ and $m=\pm\frac{1}{2}n$ in (2).

(iii) D_n – transform [$D_n(x)$ denoting Weber's parabolic cylinder functions]

$$\phi^{\frac{1}{2}n+\frac{1}{4}}_{\pm\frac{1}{4}}(p) = 2^{-\frac{1}{2}n}\,p\times$$

$$\int_0^\infty D_n(2\sqrt{xp})\,f(x)\,dx.$$

This is obtained by taking $k=\frac{1}{2}n+\frac{1}{4}$ and $m=\pm\frac{1}{4}$ in (2).

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Lucknow University, R. S. VARMA.
April 6, 1946.

1. See Widder, *The Laplace Transform* (Princeton University, 1943, and Meijer, *Proc. Kon. Akad. v. Wetensch, Amsterdam*, 1941, **44**, 727–37. 2. Whittaker and Watson, *Modern Analysis*, (fourth edition, 1935), 337–54. 3. Van der Pol, *Phil. Mag.*, 1929, **8**, 864–5. 4. Humbert, *Bulletin de la Soc. Mathematique*, 1937, **65**, 3.

A MODIFIED DEFINITION OF PROBABILITY

THE author of a recent paper[1] on the definition of probability points out that the Von Meyses' definition of probability, namely, that probability p is the limit of the sequence s/n as n tends to infinity, where s is the number of successes in n trials, imposes a restriction on the number of successes in m trials succeeding a certain number of n trials. If μ denotes the number of successes in m trials, namely, from $n+1$th to the $n+m$th, μ should lie between $(p-\epsilon)\,m-2\,\epsilon n_0$ and $(p+\epsilon)\,m+2\,\epsilon n_0$ for every $n \geqslant n_0$. This has been derived from the fact that $s/n \to p$ and $\frac{s+\mu}{n+m} \to p$. It is argued that since ϵ is a small quantity, the above restriction implies that μ should lie between the narrow limits $(p-\epsilon)m$ and $(p+\epsilon)m$; whereas μ can take any value from 0 to m.

It is surprising that the author has gone so far to get this restriction, which is obvious on the face of the definition itself. For mp denotes the expected number of successes in m trials, and when m is sufficiently large μ should lie between $m(p-\epsilon)$ and $m(p+\epsilon)$; this is true because p is the limit of μ/m as m tends to infinity. It is not advisable to consider the m trials made after the nth trial separately. Either they can be considered as two separate experiments or may be considered as one experiment of $n+m$ trials. Further when p is defined as the limit of s/n as n tends to infinity, it naturally means that s should lie between $n(p-\epsilon)$ and $n(p+\epsilon)$. It is only this principle that is revealed even in the case of the m trials succeeding the first n trials; and shows that μ should lie between $m(p-\epsilon)$ and $m(p+\epsilon)$ when m is large. There is nothing wrong in this. The fact that the number of successes μ may be anywhere from 0 to m in m trials, is equally true in the case of the first n trials and s can take any value from 0 to n. This can never be the case. In fact the statistical definition of probability shows that s will not take any random value from 0 to n but will lie between $n(p-\epsilon)$ and $n(p+\epsilon)$; or even μ will lie between $m(p-\epsilon)$ and $m(p+\epsilon)$ when m is large. Whether it is the first n trials or last m trials, the same principle holds; the quasi-limit definition introduced in the above paper is only an unwanted burden on a pure, simple yet precise definition. On the other hand if it is conceded that μ can vary from 0 to m (*i.e.*, s can take any value from 0 to n) and recognise the possible randomness of the number of successes, we can immediately close all our books on actuarial science, stat-

istical distributions including statistical mechanics and enjoy peaceful rest.

Mysore, V. S. ANANTHACHAR.
September 21, 1946.

1. *Theories of Probability*, by Jagit Singh, p. 257. *Sankhya*, April 1946, 7, Part 3.

A NOTE ON THREE NUMBERS IN A.P.

1. IN what follows A-G.P. stands for Arithmetico-Geometrical Progression, and I.R. for Indicator of Ratio of A-G.P., which means the common ratio of the component geometric series of A-G.P.

2. *Lemma.*—If a, b, c are in A.P., then a, $\frac{ab}{c}$, $\frac{a^2}{c}$ are also in A.P.

c, b, a are in A.P. (given).

Multiply each by the same number $\frac{a}{c}$ the result follows at once.

3. *Theorem.*—Any three numbers in A.P. are also A-G.P. having I.R. equal to the quotient obtained by dividing the third number by the first, provided neither the first nor the third number is zero.

Let the given numbers in A.P. be a, b, c, where $a \neq 0$ and $c \neq 0$.

These numbers can be written as

$$a, \frac{ab}{c}\left(\frac{c}{a}\right), \frac{a^2}{c}\left(\frac{c}{a}\right)^2, \qquad (1)$$

which can be obtained by multiplying the corresponding terms of the following sets:

$$1, \frac{c}{a}, \left(\frac{c}{a}\right)^2, \qquad (2)$$

$$a, \frac{ab}{c}, \frac{a^2}{c}. \qquad (3)$$

Clearly (2) is a G.P., (3) is an A.P. (Lemma).

$\therefore$ (1) is an A-G.P. having $\frac{c}{a}$ as I.R.

Hence the theorem.

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December 7, 1946.

FURTHER CONSEQUENCES OF THE "ACTIVATED LAYER" POSTULATE IN THE MECHANISM OF THE *LIGHT-EFFECT*

§1. THAT the *light-effect* Δi, a reversible and (sensibly) instantaneous current-change, on irradiation from extreme red[11] to X-rays,[11a] of chlorine and a number of other gases and vapours, is (so far) observed with semi- and full ozoniser discharges,[1,2] suggests that a dielectric surface is necessary for its occurrence. The ozonizer (Fig. 1*a*) is equivalent to a compound condenser, consisting of three serial capacities: C_1 and C_2 are associated with the inner and outer electrode walls respectively; the annular space filled with the gas represents the third, C_g. As illustrated by the generally low dielectric constants of gases, C_g is the smallest capacity; and is therefore, a chief determinant of i at a given potential V applied to the system.[4] The combined capacity

Fig. 1(a)

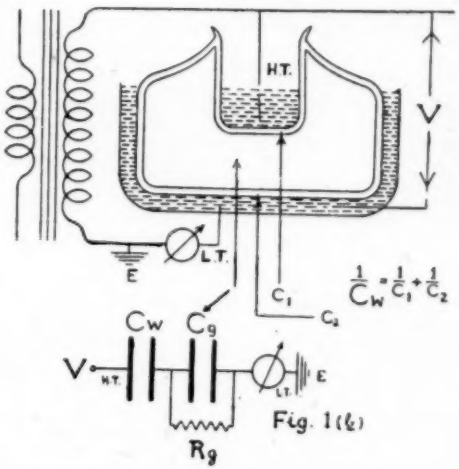

Fig. 1(b)

due to the inner and outer annular walls may be denoted by C_w, defined by $\frac{1}{C_w} = \frac{1}{C_1} + \frac{1}{C_2}$. At the *'threshold potential'* V_m,[3,4] the gas breaks down as a dielectric; the corresponding C_g may, therefore, be treated as a condenser shunted by an ohmic resistance, R_g; this represents the inverse of conductivity produced in the gas due to ionisation by collision under field due to V.

§2. The instantaneous i in the circuit may be denoted to a good approximation by,

$$i = \frac{V}{j\mathrm{L}\Sigma f + \frac{1}{jC_w\Sigma f} + \frac{1}{\frac{1}{R_g} + jC_g\Sigma f}} \qquad (i)$$

where Σf represents not only the frequency of the A.C. supply and its harmonics but also those produced under electrical discharge in the annular space due[6,7,8,2] to V. The *light-effect* Δi is observed at constant V; the corresponding circuital inductance L does not change sensibly. It follows, therefore, from (i) that the production of, *e.g.*, photo-diminution Δi implies an increase of R_g; that is, decrease of the ohmic or the conduction current; or/and decrease of either or both the capacities C_w and C_g, due to the annular walls and the excited gas, respectively.[9] In a semi-ozoniser, the capacity C_1 is absent; it produces, however, a comparatively large $-\Delta i$ (as also $+\Delta i$ under appropriate conditions *vide infra* para 4). That a preponderatingly large photo-change, *e.g.*, increase of R_g might mask a possible variation of either or both C_w and C_g in a sense opposite to that contemplated in the

above deduction, *viz.*, a decrease, requires further investigation.

Below V_m there is no ionisation current in the gas,[3,4] i.e., R_g is infinite. The non-occurrence of the *light-effect* below[2,6,7,10] V_m despite intense irradiation in the ultra-violet[11] and even X-rays,[11a] suggests from (i) that the above capacities are not altered sensibly by a mere optical excitation of the gas. The term $\left(\frac{1}{R_g} + j C_g \Sigma f\right)$ is small at low V; and sensitive to change with a corresponding marked effect on $-\Delta i$. It follows, therefore, that relatively, $-\%\Delta i$ should be low (numerically) at large V, subject to the assumption that C_w is not affected sensibly; this deduction is in accord with the generality of the results in these Laboratories which show that $-\%\Delta i$ is a maximum near V_m and decreases thereafter.[1,2,11]

§3. A possible mechanism was developed previously for the decrease by light of $1/R_g$ the ionisation current, from a consideration of the corresponding behaviour of the (electrically) *excited* gas;[1,2,11,12] this has considerable electron affinity, *e.g.*, about 4·8 volts for normal Cl, and greater if *excited*.[11,2] An assumption was then made that a photo-electric emission from an activated electrode layer(s) in dynamical equilibrium with the gas phase is a primary reaction;[11,13] the conversion of these photo-electrons into slow moving negative ions due to the electron affinity of the excited medium should reduce i, as in the space charge effect.[12,13] That the numerical decrease of $-\%\Delta i$ in various gases is as $Cl_2 > Br_2 > I_2$, $HCl > O_2$ Air $> H_2 > N_2$, Ne; and the increase in the normally low $-\Delta i$ in air due to traces of impurities as $Cl_2 > Br_2 > I_2$, which is also the order for their electron affinity, receives a simple explanation. Franck and co-workers, especially Compton, have argued that '*excitation*' of even metallic and rare gas atoms increases appreciably their electron affinity. Anticipated from these considerations, appreciable $-\Delta i$ has actually been observed by the author in vapours of alkali metals (*e.g.*, over 30% in potassium vapour, near V_m; and by Prasad in these Laboratories in mercury vapour; $-\%\Delta i$ has been more than suspected in other similar systems which previously failed to show it due to limitations of the available detector. Being formed on a dielectric surface, this layer might contain ions of both signs (*vide infra* para 4); their electrostatic and inductive influence on the ions and molecules in the gas phase, modifies the annular capacity C_g distinctive of the normal gas.[12,13] A photo-electric emission from this electrode layer entails a capacitative change[12,13,9] in C_g (and, therefore, a phase-shift)[9,13,4] leading to the *light-effect* $-\Delta i$ from (i). This postulate of an electrode layer[12,13,4] is found useful in interpreting results for the '*zero order*' discharge reactions[14] and of a new type of a wide-spread '*periodic effect*'[1,4,14,15] under certain conditions of electrical discharge. (*a*) Prolonged 'aging' under the discharge; or/and surface 'impurities' should affect the 'work function' determining the behaviour of the electrode-layer;[12,13,4] and, therefore, magnitude of the corresponding '*periodic effect*'[1,4,14,15] and especially $-\Delta i$.[31] (*b*) Also on this view, the relative $-\Delta i$ should increase (numerically) by increasing *ceteris paribus* the surface area in the excited system. (*c*) On the other hand, use of high potentials and especially heating would cause irreversible desorption and depolarisation of the ions and other particles constituting the semi-gas, electrode layer; these would instabilise it, and therefore, reduce the corresponding $-\Delta i$ and also the '*periodic effect*'.[1,4,14,15] These predictions *a,b,c* are fully borne out by experimental results. In $-\Delta i$ the minimum time-lag[6,7,2,13] is remarkably small, of the order of a micro-second or even less. It is not unlike the 'relaxation time', as suggested particularly by the production of an appreciable $-\Delta i$ *under H·F. discharge*. This indicates that compared with the '*periodic effect*',[1,4,14,15] $-\Delta i$ originates from a more elementary and reversible light-action such as, *e.g.*, an ionic exchange or/and orientation between the electrode layer and space charge in the excited gas.

§4. It is significant for the general mechanism of the *light-effect* phenomenon that $-\Delta i$ is much wider occurrent than the positive effect, $+\Delta i$. The latter, however, is to be anticipated from the greater probability of photo-ionisation of pre-excited particles.[11a,5] Large $+\Delta i$ has been observed[1,9] in numerous cases under insufficiently understood conditions such as, special coating materials on the angular walls, *e.g., with* $KI_3 + KI$ mixture, vapours of iodine, phosphorus and sulphur. An abnormal working of a metal oxide type detector; spontaneously, after long 'aging' at a constant V in a semi-ozoniser excitation, etc.; a *low* applied V would appear to favour $+\Delta i$ under these conditions. A *positive* effect is also observed especially under heavy inputs to a triode, tetrode and pentode. The photo-electric action is assumed to be fundamental to the general *light-effect* mechanism (*vide* §3).[12,13] From equation (i), $+\Delta i$ implies (subject to the assumptions discussed in §2) an *increase* of the conduction current $1/R_g$, or/and of the capacities C_w and C_g. The electrode-layer mechanism suggests that $+\Delta i$ may be attributed to an emission of the positive ions under light, which comparatively is less frequent than the electronic emission. The author's finding *that the high frequency region of i is the chief seat of the light effect*[8,6,9] has now been substantiated by numerous results over a wide range of conditions of excitation and detection. It is of considerable interest, therefore, to record here the observation of over 40 per cent. *positive* effect reproducible *ad libitum* in chlorine with but ordinary light, *under H·F. excitation near* V_m; and *also at low frequency excitation*, when the relative surface is multiplied by introducing powdered wall material in the annular space; this was suggested by the marked significance to the *light-effect* phenomenon of the solid-gas interface and its immediate neighbourhood in the gas phase.[1,9,5,16] With both these modes of excitation (up to a limit, §2), a larger V reveals the more familiar $-\Delta i$ as large as 40 to 70 per cent. current decrease; the transition $+\Delta i \rightleftarrows -\Delta i$ is potential reversible; near the

special case $\Delta i = 0$, the system shows especially under H.F. excitation, a characteristic instability.

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Benares Hindu University, S. S. JOSHI.
November 13, 1946.

1. Joshi, *Presi Addr., Chem. Sec., Indian Sci. Cong.*, 1943. 2. —, *Proc. Indian Acad. Sci.*, 1945, **A22**, 389–97. 3. —, *Curr. Sci.*, 1939, **8**, 584. 4. —, *ibid.*, 1946, **15**, 281. 5. —, *ibid.*, 1945, **14**, 35. 6. —, *ibid.*, 1944, **13**, 253. 7. —, *Nature*, 1944, **154**, 147. 8. —, *Curr. Sci.*, 1945, **14**, 67. 9. —, *Proc. Indian Acad. Sci.*, 1945. **A22**, 225. 10. Joshi and Lad, *ibid.*, 1945 **A22**, 293. 11. —, *Curr. Sci.*, 1945, **14**, 317; 11*a*. —, *ibid.*, 1944, **13**, 278. 12. —, *Proc. Indian Sci. Cong., Phys. Sec.*, Abst 26 (1946). 13. —, *ibid.* (communicated). 14. —, *Curr. Sci.*, 1946 **14**, 175. 15. Joshi and Deshmukh, *Nature*, 1945, **155**, 483. 16. Deo, *Proc. Indian Acad Sci.*, 1945, **A21**, 76–80. 17 Prasad, *Nature*, 1945 **155**, 362. 18. Tiwari and Prasad, *Curr. Sci.*, 1945, **14**, 229. 19. Das-Gupta, *Sci. and Cult.*, 1945, **11**, 318. 20. Sahay, *Curr. Sci.*, 1945 **14**, 122. 21. Deb and Ghosh, *Sci. and Cult.*, 1946, **12**, 17.

ASYMMETRY OF SHAPE AND PERIODS OF OSCILLATION IN ELECTRIC FIELDS

KRISHNAN, Guha and Banerjee* showed that the period of oscillation of an isotropic body suspended in a uniform magnetic field is not appreciably affected even when there is a considerable asymmetry of shape. Different results are to be expected in an electric field. In accordance with such an expectation, the following interesting observations have been made by the author.

The period of oscillation of a rectangular glass plate, with sides in the ratio 1 : 2 and suspended by a silk fibre about an axis perpendicular to the plate in a uniform electric field, is determined at various field strengths. A definite relationship between the period and the field strength is found to exist.

The period, provided the torsion of the fibre is nil, may be expected to be inversely proportional to the voltage employed for obtaining the field between two parallel plates. If there is a finite torsion of the suspending fibre, which is the case in the experiment conducted, the period may be corrected for the torsion by forming a quantity T′ equal to $T\sqrt{\frac{T_0^2}{T_0^2 - T^2}}$ where T and T_0 are respectively the periods in the field and out of the field. T′ is found to vary inversely with voltage. Graphs between $\frac{1}{T'}$ and the voltage, obtained in several typical experiments with rectangular bits of glass, are found to be straight lines. It is also observed that T′ is the same whether the voltage applied is a direct or an alternating one.

The results are now published with a view to draw attention to the fact that this dependence of T′ on voltage applied between two fixed parallel plates offers a simple method of measuring voltages. Though it takes some time for making such measurements, this method has the advantage of using very simple apparatus available in any laboratory.

While seeking for the origin of the turning moment on suspended bodies which have only a shape asymmetry but no dielectric anisotropy, it has been found that $\frac{I}{T'^2 V^2}$ is the same for rectangular pieces of glass, ebonite and lead, provided the shape and dimensions are kept constant. I is the moment of inertia of the body about the axis of suspension, and V is the applied voltage. From this observation, it is to be concluded that the turning moment is due to an asymmetric distribution of the accumulated charge on the surface of the suspended body and not due to the asymmetry of the field within the body or to the dielectric nature of the body.

In the magnetic case, where there are no surface effects and where the difference in the internal fields arising out of demagnetisation is very small, effects analogous to the above cannot be expected.

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December 16, 1946.

* *Phil. Trans.*, A, 1933, **231** 235.

MOLECULAR STRUCTURE OF CH_3CN

IF the C—C≡N chain in CH_3CN is linear, that is, if the molecule is axially symmetric having a three-fold axis of symmetry, it should give rise to four totally symmetric and four doubly degenerate vibrations. All of them would be Raman-active. If the chain is not linear, each degenerate vibration splits up into two so that we should expect twelve fundamentals which are Raman-active.

The Raman spectrum of CH_3CN has been studied by a few authors. Ten Raman lines have been recorded. The number of the observed Raman lines alone will not help us to fix up the structure of CH_3CN molecule. The polarisation data are essential to decide the structure but they are not available.[1]

The author has undertaken the polarisation measurements of the Raman lines in CH_3CN. The usual condenser method of illumination has been used and a properly oriented Wollaston double-image prism placed in the path of the scattered beam enabled us to photograph the horizontal and the vertical components simultaneously. The polarisation measurements of six Raman lines have been made. The remaining four lines are extremely weak and their polarisation characters could not be studied. Four lines at 920, 1375, 2250 and 2940 cm.$^{-1}$ have been found to be well polarised. They can be taken as the four total symmetric lines. Two lines at 380 and 3000 cm.$^{-1}$ are depolarised. The observed polarisation characters of the Raman lines in CH_3CN are strongly in favour of the symmetrical model.

Details will be published elsewhere.

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Waltair, K. VENKATESWARLU.
December 9, 1946.

1. Herzberg, *Infra-Red and Raman Spectra of Polyatomic Molecules*, p. 332.

BORIC ACID *AND THE O-HYDROXY-CARBONYL COMPOUNDS*; MELTING POINT *CURVES*

It is well-known that boric acid exerts remarkable effects on the optical rotation and electrical conductivity of aqueous solutions of polyhydric alcohols, phenols and hydroxy acids such as malic, tartaric and salicylic acids. As an explanation, compound formation has been assumed by van't Hoff, Boeseken and others but complete and satisfactory evidence for this view has been lacking, the chief difficulty being isolation of compounds which undergo hydrolysis very readily. Bancroft and Davis[1] explain the well-known increase in acidity, of an aqueous solution of boric acid on the addition of glycerine, as due to an increase in the ionisation, the ionising power of aqueous glycerine being greater than that of water. For a critical account of the large amount of literature on the subject, the paper by these authors may be referred to.

Of the large number and wide variety of *o*-hydroxy-carbonyl compounds available, only salicylic acid has received attention so far in this connection. There is evidence to show that boric acid reacts with *o*-hydroxy carbonyl compounds in the presence of a dehydrating agent, producing complex chelate structures which exhibit prominent colour changes or fluorescence. Mention may be made of the work of Dimroth,[2] Feigl,[3] Neelakantam[4] and others. The present authors have, therefore, undertaken systematic investigation of compound formation with them.

As the first part of the investigation, the melting point curves of boric acid in the presence of some *o*-hydroxy-carbonyl compounds, which were synthesised for this purpose, have been constructed. The determination of the melting point of boric acid itself is complicated by the fact that it readily undergoes dehydration. Apparently this is responsible for some contradictions in literature regarding its stability and melting point. Philbrick and Holmyard[5] state that at 100° C. or a little over, boric acid forms the meta-acid, at 140° C. the pyro-acid and the anhydride is obtained only by strong heating. Hackspill and Kieffer,[6] on the other hand, state that the ortho-acid is stable only up to 90° C., at 100° C., the decomposition is explosive and 95 per cent. of the water is lost forming boric anhydride with a little water of adsorption and at 250° C. all the water is lost. Stackelberg, *et al.*[7] report 170° C. for the ortho-acid. Mehta and Kantak[8] recently calculated the melting point of the ortho-acid from the data obtained by them for melting points of mixures with glucose, galactose and tartaric acid. Their values are 169·5, 170·5 and 160·9° C. respectively. The considerably low value obtained in the last case is ascribed to compound formation. By melting the boric acid in a corked test-tube and determining the m.p. of the powdered melt we obtained 177° C.

Mixtures of boric acid and the organic compound in known proportions were prepared by weighing the two components in ignition tubes, sealing off the tubes and heating the tubes gradually in a sulphuric acid or glycerol bath. In all cases excepting 2-acetyl-1-naphthol, there was an initial lowering of the melting point of boric acid. The melts were quickly powdered and the melting points taken.

In the following table, the maxima temperatures and molecular ratios corresponding to them read out from the graphs constructed are shown.

Surprisingly enough the last compound caused an initial rise in the melting point of boric acid instead of the usual lowering on addition of the substance. Evidence for compound formation is indicated in the curves. The molecular ratios, however, indicate that the matter is more complicated. Further investigation is in progress.

TABLE I

Serial No.	Compound	M.P. °C.	Maxima °C.	Molecular ratios	
				Boric acid	Compound
1	Resacetophenone	143	196	4	1
2	Gallacetophenone	171	195	4	1
			182	2	3
3	Resorcylic aldehyde	135	199	3	1
4	2-Acetyl-1-naphthol	102	220	3	1

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December 21, 1946.

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ELECTROLYTIC HYDROGENATION OF CRESOLS

BANCROFT and George[1] have shown that the hydrogenation of phenol at a platinised-platinum cathode is not an electrolytic process and is probably the result of oriented adsorption of the phenol molecule, the platinised-platinum acting as a source of hydrogen. It was thought that a study of the hydrogenation of the three isomeric cresols under the same conditions would throw greater light on the mechanism of hydrogenation at the cathode, besides revealing the influence of substitution on the process of hydrogenation. The results obtained in the course of the study not only supports the view of the authors referred to above but also shows that the extent of hydrogenation is different in the case of each cresol as could be seen from the results given below:

o-*Cresol*	m-*Cresol*	p-*Cresol*
33·5%	41%	24·3%

(1/20 gm. mol. of each cresol was hydrogenated in a porous pot in 22 per cent. sulphuric acid with vigorous stirring, the C.D. being 4 amps./dm.^{2} The theoretical quantity of current, 6 F./mol. was passed in each case.)

The maximum yield of hydrogenated product is obtained with *m*-cresol. The variation is due evidently to the influence of the position of the methyl group on the oriented adsorption of the cresol molecule on the electrode surface.

The hydrogenated product was found to be a mixture of methyl cyclohexanol and the corresponding methyl cyclohexanone. Analysis by Bennett and Donovan's hydroxylamine method[2] showed the product in each case to contain the proportions of ketone indicated below:

	o-*Cresol*	m-*Cresol*	p-*Cresol*
Ketone %	32·8	50·0	36

An entirely different effect was noticed when a cathode consisting of a mixed deposit of platinum and palladium in equal proportions was employed. The results are summarised below:

	o-*Cresol*	m-*Cresol*	p-*Cresol*
Total yield of hydrogenated product	25%	32·9%	43%
Ketone%	55%	80·1%	62·7%

Vavon and Berton[3] have reported the formation of ketones during the hydrogenation of cresols in the liquid phase using platinum black catalyst. The hydrogenation at the platinised-platinum cathode is exactly similar. It is, therefore, to be concluded that the hydrogenation is purely catalytic, and not electrochemical.

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Madras,
December 18, 1946.

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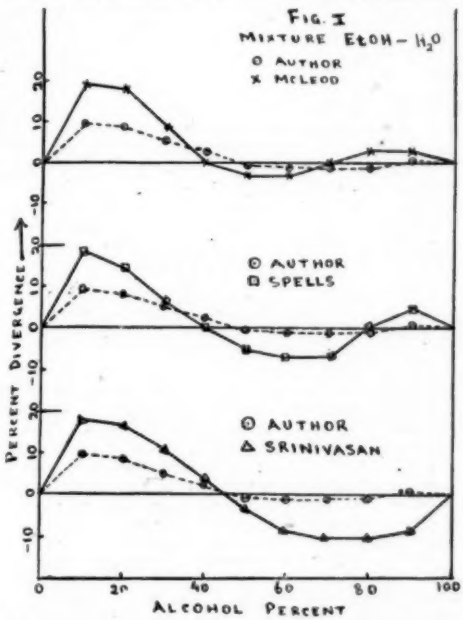
AN EQUATION FOR THE VISCOSITY OF NON-IDEAL LIQUID MIXTURES

AN equation developed on the basis of Newton Friend's[1] Rheochor, in which account has been taken of the change in density occurring on mixing two liquids, is found to represent satisfactorily the viscosity variation of non-ideal liquid mixtures with their composition. This may be stated as:

$$\eta^{\frac{1}{3}} = \left(\eta_1^{\frac{1}{3}} \cdot \frac{M_1}{\rho_1} \cdot x + \eta_2^{\frac{1}{3}} \cdot \frac{M_2}{\rho_2}\,(1-x)\right) \times \left(\frac{\rho}{M_1 x + M_2 (1-x)}\right)\left(\frac{\rho}{\rho_1 + x\rho_2\,(1-x)}\right)^m$$

where η, ρ denote viscosity and density of mixture; η_1, ρ_1 and η_2. ρ_2 the same quantities for



the two components and M_1, M_2 their molecular weights; x the weight fraction of the first component; m an arbitrary constant.

The equation represents data on a number of non-ideal binary mixtures[2,3,4] (showing different types of curves) quite satisfactorily, as will be apparent from a perusal of Table I which gives data for typical cases of good, fair and bad fits. In some cases, the equation agrees with data within much closer limits than other equations (McLeod,[4] Spells,[5] Srinivasan[6]). Thus, for the remarkably non-ideal mixture ethyl alcohol-water, which is not satisfactorily represented by any equation, the maximum divergence with the present equation is 9·7 per cent., as against 18·8, 18·1 and 18·0 per cent. for the other equations mentioned. Fig. 1 shows graphically the percentage divergence from experimental values (for each equation) plotted against composition of the mixture and the curves clearly demonstrate the superiority of the present equation.

TABLE I

Weight per cent. (first component)	Density	η (observed)	η (calculated)	Per cent. difference
Good fit: Pyridine-Benzene: Curve almost linear: $m = 0$.				
0	0·87374	0·006038	0·006038	0
39·73	0·91444	0·007169	0·007059	1·5
59·35	0·93465	0·007726	0·007579	1·9
79·64	0·95564	0·008345	0·008264	0·9
89·77	0·96600	0·008601	0·008367	2·7
100	0·97832	0·008775	0·008775	0
Fair fit: Pyridine-Ethyl alcohol: Curve shows minimum: $m = -1$.				
0	0·79037	0·011532	0·011532	0
29·92	0·84317	0·010340	0·010044	2·9
49·97	0·88449	0·009591	0·009136	4·7
66·07	0·92418	0·008792	0·009077	−3·2
79·96	0·94564	0·008773	0·009107	−3·8
100	0·97832	0·008775	0·008775	0
Bad fit: Ethyl alcohol-Water: Curve shows maximum: $m = 2$.				
0	0·99973	0·01308	0·01308	0
10	0·98393	0·02179	0·01967	9·7
20	0·97252	0·03165	0·02901	8·3
30	0·95977	0·04150	0·03833	5·3
40	0·94238	0·04391	0·04278	2·5
50	0·92162	0·04180	0·04202	−0·5
60	0·89927	0·03770	0·03822	−1·3
70	0·87602	0·03268	0·03315	−1·4
80	0·85197	0·02710	0·02734	−0·8
90	0·82654	0·02101	0·02119	0·8
100	0·79784	0·01466	0·01466	0

The constant m in the equation ranges between $+4$ and -4 in the cases examined and is 0 for mixtures showing almost linear or slightly sagged curves. The corresponding constant in Srinivasan's equation assumes very high values, varying from $+16$ to $-18·5$. As compared to McLeod's two-constant equation, the present equation has one constant only.

Central Research Station,*
Dept. of Agriculture,
Pusa, A. S. CHACRAVARTI.
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* This work was done in the Chemical Laboratory, Science College, Patna.

A SIMPLE INEXPENSIVE HAND-MICROTOME

IN experiments on suction pressure, permeability and rate of uptake of salts and water by plant cells use is often made of thin discs of potato tuber, carrot, etc.[1,2,3] It is essential to minimize the time lag necessary for the different layers of cells to reach the same stage of water uptake by using sufficiently thin discs of uniform thickness.

In the course of work on the oxidation of potato tubers at this Institute a simple hand-microtome illustrated in Fig. 1 was developed. It consists of a cork-borer, 1-2 cm. in diameter, fitted with a glass plunger which is calibrated into 1·0 mm. marks. The scale is drawn on a piece of paper and introduced into the glass tube. Melted paraffin is then poured into the tube to hold it in position.

In order to operate the apparatus the glass plunger is removed from the cork-borer and a symmetrical cylinder of potato tuber is bored out. The plunger is then introduced into the cork-borer and pushed sufficiently in to make contact with the lowest end of the cylinder of potato tuber contained in the cork-borer. The plunger is now pressed in so that the cylinder of potato tuber juts out at the upper end of the borer. A sharp blade is held in level with the rim of the cork-borer and with a quick horizontal sweep a disc is cut from the exposed end of the potato cylinder. First two or three cuttings are discarded as the discs are likely to be uneven. Thereafter the plunger is pressed in gently 1 mm. at a time and discs are cut.

Mean fresh weight per disc in mg. is given for six experiments (each with 25 discs) in table below:—

Mean weight per disc (mg.)	
Expt. No.	*Disc wt.*
1	142
2	136
3	138
4	140
5	138
6	133

The agreement appears to be fairly good.

This apparatus has the following advantages over a standard hand-microtome which is generally used by research workers engaged on problems of permeability and absorption and

accumulation of solutes by living plant cells: (i) It is simple and inexpensive in design; (ii) in the case of a hand-microtome the soft tuber material will have to be either unsupported or mounted in pith which often leads to uneven cutting. The cork-borer used in

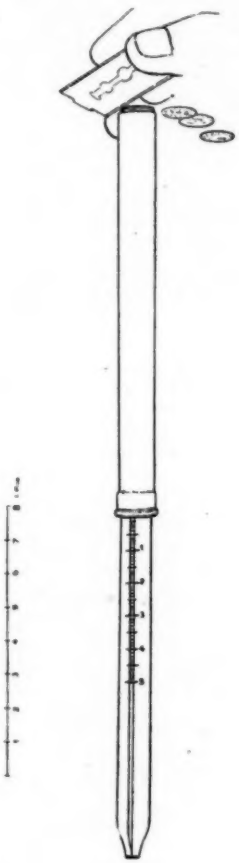

FIG. 1

this apparatus, on the other hand, gives a good support to the material during the process of cutting discs thus ensuring a fairly uniform surface.

For the above-mentioned experiments it is of course necessary to have as thin and even a disc as possible. The ideal condition would be to have only one layer of cells as pointed out by Baptist. It is, however, very difficult in practice to achieve this without injuring the cells. The difficulty is obviously overcome by cutting discs having four or five layers of cells which have been found to sufficiently minimize the time-lag necessary for the different layers of cells to attain equilibrium.

As use of a razor or a razor blade is common to the present arrangement as well as to any standard hand-microtome available in the market the uncertainties of the personal factor are likely to affect the evenness and contour of the cut surface. This constitutes a serious drawback in instruments of this nature.

This defect can, however, be remedied by making use of a mechanical device for cutting sections. Attempts are being made at this Institute to make a hand-microtome with a mechanical device for cutting sections.

In the meanwhile it is hoped that this simple device will prove useful to research workers as well as to teachers for practical demonstration work in physiological laboratories.

Division of Botany,
Indian Agric. Research Institute,
New Delhi, J. J. CHINOY.
December 5, 1946.

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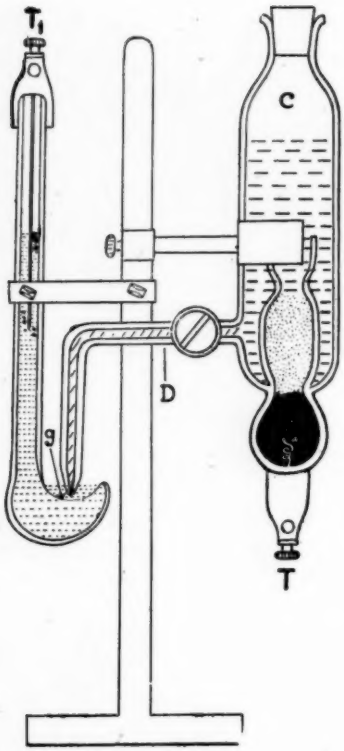
A MICRO-GLASS ELECTRODE FOR pH DETERMINATION

ATTEMPTS[1,2,3,4,5] have been made from time to time to construct glass electrodes of suitable designs. They, however, suffer from serious disadvantages such as difficulties in cleaning and filling, leakage paths necessitating thorough insulation, requirement of 20 to 30 ml. of liquid of unknown pH, high resistance of the system, etc. Claff[2] has recently devised a glass electrode for determination of pH of small quantities of culture media. Great care has to be exercised in preventing air bubbles from vitiating pH measurement with such a glass electrode.

In the course of physiological work on soil-plant growth, a need was felt for designing a glass electrode which could be used with very small quantities of plant extracts. Essential details of such an electrode are featured in Fig. 1.

The conducting membrane *g* (about 25 μ in thickness) is blown in the form of a small cup (15 mm. diameter, 7 mm. depth) in the upper region of an eccentrically blown bulb of (Corning 015) glass of high conductivity which is itself quite thick-walled. The total capacity of the cup is about 1 ml. The bulb is filled with a saturated solution of quinhydrone in 1 N HCl. Contact is made by a platinum wire connected with the gold plated terminal T_1. Contact between the liquid of unknown pH and the saturated calomel electrode C is made by means of the KCl-bridge D in such a manner that the end of the tube rests just above the glass membrane *g*.

Method.—A Cambridge Direct Reading pH Meter calibrated for a range of 14 pH units (Cambridge Instruments for Hydrogen-ion measurements List, No. 108) was found to be suitable in combination with the above electrode system. The standardization of the instrument is checked at frequent intervals.



Comparative pH determinations of buffer solutions

Temperature of solutions — 20–22°C.	
pH by	
Micro glass electrode	Standard glass electrode
3·57	3·98
4·64	4·63
4·58	4·60
4·59	4·59
5·58	6·00
6·89	6·89
7·69	7·70
9·27	9·26
8·69	8·70
2·35	2·35
3·11	3·12
4·23	4·25
5·47	5·45
6·64	6·63
7·94	7·93
9·11	9·12
10·24	10·24

Cleaning of glass electrode cup did not present any difficulty. A small piece of cotton-wool or soft filter paper was introduced to absorb the liquid and the cup was washed 2-3 times by directing a thin jet of distilled water on the end of the KCl-bridge and opening the stop-cock for a moment to flush out the end of the bridge. Once the electrodes were adjusted no need was felt for disturbing their relative positions thus ensuring the safety of the glass membrane. A thin layer of liquid paraffin on the surface of the solution has been found to prevent evaporation quite satisfactorily.

The glass electrode was tested thoroughly by using various standard buffers. The results were compared with those obtained by the standard glass electrode. There is a close agreement between the pH values determined by the micro-glass electrode and also by the standard glass electrode.

Division of Botany,
Indian Agric. Research Institute,
New Delhi, J. J. CHINOY.
December 9, 1946.

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A NOTE ON MOSAIC VIRUS OF SANN-HEMP (*CROTALARIA JUNCEA* LINN.) AND ITS CRYSTALLISATION

A MOSAIC disease of sann-hemp (*Crotalaria juncea* Linn.) was found to be of widespread occurrence during the early part of 1946 at Delhi.

The first visible symptom of the disease is mottling of the leaf. As the disease progresses patches of light and dark-green areas become more prominent. A diseased leaf is much smaller than a healthy one (Fig. 1); in the case of severe infection the growth of the lamina is abnormal (Fig. 2). Frequently, the dark-green areas on the upper surface of the lamina are raised with a corresponding depression on the under-surface (Fig. 1).

A microscopical comparison of sections of healthy and diseased leaves revealed some important differences in the mesophyll tissues (Fig. 3). In the chlorotic area of an infected leaf the tissue is thinner with fewer intercellular spaces, and in severe infection the mesophyll is not differentiated into palisade and spongy parenchyma; the cells are more or less isodiametric in transverse section. The chloroplasts in these cells are rather indistinct. No marked abnormality was observed in the vascular tissue of diseased leaves; occasionally, only a few cells in the phloem tissue were found to be hypertrophied.

Inoculation of plants by rubbing expressed sap from diseased plants transmitted the virus; typical symptoms appeared on inoculated plants within six to eight days after inoculation.

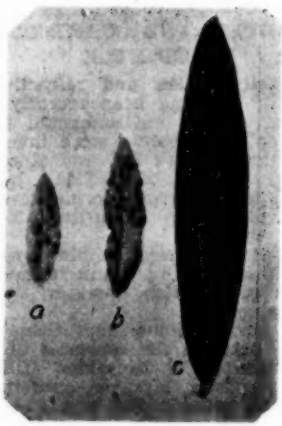

Fig. 1, *a* and *b*, infected leaves of sann-hemp showing typical symptoms of mosaic disease: *c*, healthy leaf of sann-hemp.

Fig. 2, *a*, abnormal growth of the lamina in a severely infected leaf.

Similar results were obtained when carborundum was used as an abrasive. Disease symptoms were produced within three to four days when the young leaves were punctured with insect needles previously dipped in the inoculum. Control plants were similarly treated with distilled water instead of expressed sap from diseased plants; they were included in every test; they remained healthy. Under glass-house conditions the leaves of inoculated plants are affected from a very early stage of their development.

The virus has a thermal death point of 68-70° C., a longevity *in vitro* of 71-76 days, and can tolerate a dilution of between 1 : 1000-1 : 5000.

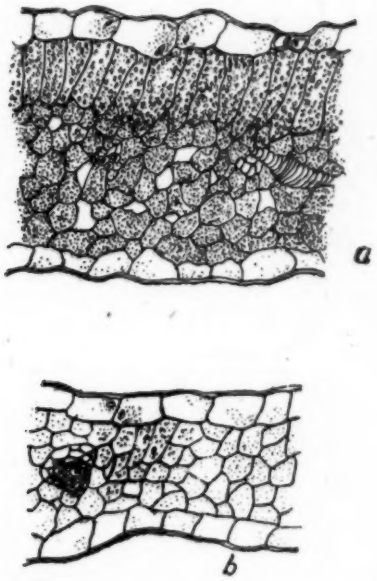

Fig. 3, *a*, t.s. of a healthy leaf × 70: *b*, t.s. of a diseased leaf × 70.

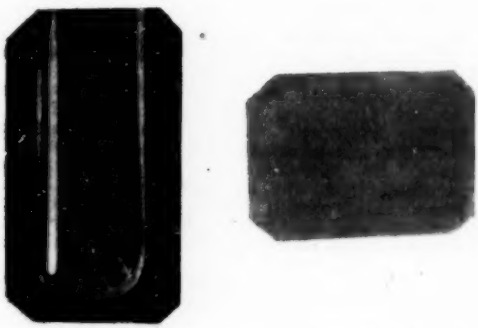

Fig. 4, a white jelly like material accumulated at the bottom of the centrifuge tube.

Fig. 5, acicular crystals of sann-hemp mosaicvirus × 10

The sann-hemp mosaic virus could not be transmitted to cowpea [*Vigna unguiculata* (Linn.) Walp.], neither could cowpea mosaic virus, which is of very frequent occurrence at Delhi, be transmitted to sann-hemp. Dale[1] reported a mosaic virus of *V. unguiculata* from Trinidad, and concluded from his experiments that the virus of *V. unguiculata* and sann-hemp are one and the same, since the disease could be transmitted from the former to the latter and *vice versa*. The Trinidad virus is, therefore, different from the one collected at Delhi.

Fukushi[2] recorded a mosaic of *Crotalaria juncea* from Japan; since no experimental work was done by Fukushi it is difficult to state if the virus occurring in India is the same as that in Japan.

The virus was purified according to the method suggested by Bawden[3] with acid and ammonium sulphate. A white pericipitate was formed at the bottom of the centrifuge tube after the preparation was centrifuged. The precipitate was repeatedly washed with water; at pH 3·3 the virus went into solution. The preparation was centrifuged at 3,000 r.p.m. in an 'Ecco' Laboratory Centrifuge; no impurity in the form of a precipitate was observed after this centrifugation. The virus was precipitated from the preparation after adjusting the pH to 4·2 by the addition of N/10 NaOH. The suspension was centrifuged; the precipitate was dissolved in NaOH and the pH was raised to 7·0. This solution was finally centrifuged at 3,000 r.p.m. for one hour. A colourless solution of the purified virus was thus obtained.

The preparation was later centrifuged for two hours in a centrifugal field of nearly 12,000 times gravity. A white jelly-like material accumulated at the bottom of the centrifuge tube (Fig. 4). This jelly-like material was dissolved in water and centrifuged again for one hour at 3.500 r.p.m. A glassy crystalline mass accumulated at the bottom of the centrifuge tube. The supernatant was poured off and discarded. A few drops of distilled water were added to the crystalline mass and the preparation was poured off in a beaker which was kept at 20° C. for 4-5 hours to allow evaporation of water. Very fine glassy acicular crystals were formed on the surface of the beaker (Fig. 5).

The expressed sap collected from leaves of healthy sann-hemp plants was subjected to a similar treatment with acid and ammonium sulphate, and centrifugation, as a blank experiment. No jelly-like material or crystals as obtained from the diseased leaves of sann-hemp plants could be isolated; this clearly indicates that they are not a normal constituent of sann-hemp plants, nor was it produced from the reagents used.

A solution of the purified crystalline preparation gave positive results in inoculation tests on sann-hemp plants and produced typical symptoms of the disease.

Further studies are in progress.

Grateful acknowledgement is due to Mr. J. F. Dastur, Imperial Mycologist, for his helpful criticisms and keen interest in the work.

Division of Mycology and
Plant Pathology, S. P. RAYCHAUDHURI.
Indian Agric. Research Institute,
New Delhi,
November 18, 1946.

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* The original paper was not available; only abstract was seen in *Rev. Appl. Mycology*.

SOME FACTORS AFFECTING THE REFRACTIVE INDEX AND CONSTANT OF MILK

THE refractive index and refractive constant, K, of milk[1,2] having been recently devised, a number of routine environmental factors that might affect their values were investigated.

The high values of R.I. and K of colostrum (cow, R.I., 1·3513, K, 0·2111; buffalo, R.I., 1·3630, K, 0·2134) reach normal levels in three to seven days after parturition, K being the earlier of the two.

The constants vary, within normal limits, from milking to milking and from day to day. The order of variation, however, appears to be unpredictable.

Within normal limits, appreciable differences also exist between the constants of milk from different quarters of the udder. Different portions of a milking, however, exhibit a more or less uniform value of R.I. and a steady rise in the value of K resulting from the progressive fall in density from fore milk to strippings. In all cases the constants of pooled milk lie within normal limits.

A marked effect of change of season on the R.I. of milk is also noticeable. With the change over from dry summer months to rainy season when lush vegetation is available for cattle there is a distinct upward shift of the limits of R.I. as seen in the following table. The limits of K, on the other hand, remain practically the same because of the more or less corresponding rise in density of milk in the rainy months.

TABLE

Limits of R.I. and K in dry and rainy seasons of the year

	Dry season		Rainy season	
	R.I.	K.	R.I.	K.
Cow ..	1·3450 to 1·3470	0·2064 to 0·2075	1·3458 to 1·3480	0·2065 to 0·2076
Buffalo ..	1·3460 to 1·3492	0·2076 to 0·2088	1·3470 to 1·3510	0·2076 to 0·2088

Rigorous heat treatment of milk like boiling for 5 and 10 minutes causes a progressive rise in the values of R.I. and K depending on loss in volume and rise in concentration of milk solids.

In general it is observed that R.I. of milk is affected by factors which affect variations in the solids-not-fat of milk. The refractive constant, however, remains within narrow limits unaffected by many of the natural factors.

My thanks are due to Mr. B. N. Banerjee and Prof. V. Subrahmanyan for their kind interest in these studies.

Department of Biochemistry,
Indian Institute of Science,
Bangalore, K. S. RANGAPPA.
December 6, 1946.

1. Rangappa, *Curr. Sci.*, 1946, **14**, 230. 2. —, *Ibid.*, p 288.

INITIATION OF LACTATION IN HEIFERS AND COWS

FOLLEY, *et al.* (1941) were successful in initiating lactation in virgin goats by rubbing diethylstilbesterol ointment on the udder. Similar results were obtained by Folley and Malpress (1944) in the case of heifers.

Two barren heifers and one dairy cow were treated with stilbesterol-dipropionate dissolved in oil. To start with all the three animals were injected 2 ml. (containing 20 mg. of stilbesterol-dipropionate) of the oestrogen. Two more injections were subsequently given.

The heifer No. 314 showed mammary development within a week. The little milk that was secreted was mixed with some blood. Intense manipulation of the udder was started and after about a week the animal's milk yield increased to 2 lbs. After a fortnight the milk became normal in appearance. The milk yield had gone up to 15 lbs. per day in 90 days after the milking was first started.

The heifer No. 445 began secreting milk about a week after the second injection and cow No. 332 came in milk a week after the first injection of stilbesterol-dipropionate.

Details of the milk yield and composition of milk are shown in the table. At the start of the lactation the milk obtained closely resembled normal milk rather than colostrum. The total proteins, solids-not-fat and chlorine were rather high and lactose percentage low compared to normal milk. The composition became almost normal after about three weeks.

The animals treated with stilbesterol-dipropionate continued to be in good health throughout the period of study. This treatment has given very promising results which may be extended with benefit on a large scale to initiate milk in barren heifers and cows whose number forms a considerable part of the cattle population of this country.

Yield and composition of milk secreted by animals treated with stilbesterol-dipropionate

Injections given	Days milking started after injection	Days in milk	Daily milk yield lb.	% Composition of milk				
				Fat	Solids not-fat	Total proteins	Lactose	Chlorine
Heifer No. 314.								
	←	→						
	—	7	1·0	3·5	11·64			
2 ml. ..	7	14	2·0	5·7	10·14	5·63	4·04	0·111
(1—4—46) ..	14	21	4·2	5·8	10·08	4·91	4·61	0·111
3 ml. ..	21	28	4·4	7·0	10·52	4·86	5·23	0·110
(11—5—46) ..	28	35	6·0	6·6	10·07	4·76	5·60	0·111
2 ml. ..	60	67	13·5	6·1	10·12	4·23	5·33	0·086
(2—6—46) ..	90	97	15·1	6·3	10·52	4·25	5·25	0·069
Heifer No. 445.								
	←	→						
2 ml. ..	—	50	0·6	4·3	10·48	5·55	4·04	0·159
(1—4—46) ..	7	57	1·1	4·7	10·15	4·56	4·71	0·123
2 ml. ..	14	64	2·9	5·2	9·80	4·18	4·97	0·106
(11—5—46) ..	21	71	3·4	6·1	9·87	4·25	5·10	0·102
2 ml. ..	28	78	4·0	6·5	9·63	4·20	5·14	0·079
(2—6—46) ..	60	110	4·7	5·8	9·25	3·95	4·90	0·069
	90	140	3·9	5·8	9·43	3·95	4·95	0·062
Heifer No. 332.								
	←	→						
	—	7	2·7	4·6	13·10	8·37	4·49	0·135
2 ml. ..	7	14	4·1	5·2	11·23	6·55	4·92	0·092
(26—5—46 ..	14	21	4·2	5·8	10·10	4·83	5·07	0·092
2 ml. ..	21	28	5·9	5·6	10·26	4·60	5·04	0·080
(15—6—46) ..	28	35	5·4	5·9	9·79	4·33	5·02	0·079
2 ml. ..	60	67	5·6	6·7	9·58	4·30	5·16	0·072
(6—7—46) ..	90	97	5·7	6·2	9·91	4·12	5·06	0·057

The authors thank Mr. M. C. Rangaswamy, Director of the Dairy Research, for his helpful suggestions.

Imperial Dairy Research Institute, Bangalore, *December* 16, 1946.

D. NARAYAN.
V. R. BHALERAO.

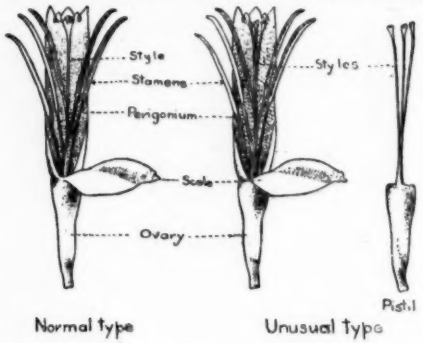
1. Folly, S. J. and Malpress, F. M., *J. Endocrinology*, 1944, **4**, 37. 2. Folley S. J., Watson, H. M. and Bottomley, A. C., *J. Dairy Research*, 1941, **12**, 24.

FLOWERS WITH THREE STYLES IN *MUSA SAPIENTUM* LINN.

Musa sapientum Linn. (*M. paradisiaca* Linn.) is trimerous in its floral organs. In a normal flower, the inferior ovary carries on it the irregular perianth in two parts, one called the

perigonium representing five perianth lobes, and the *scale* representing the sixth. Variations in number and shapes of the perianth parts have been recorded by K. C. Jacob.* Besides the five stamens which are usually found, the sixth rudimentary or fully developed one has been very often met with. Of the gynoecium, the ovary is three-carpelled and syncarpous, style single and stigma also single with undulating surface.

An unusual type with flowers having three styles was met with in one plant of the local variety, Ney Mannan (*vide* Fig.). Many of



the flowers in the inflorescence of this plant were of this unusual type mixed with the normal single styled flowers. Except for the division of the styles to the base, there was no other variation.

Transverse sections of the styles of the normal type and the unusual type were compared. While the normal style has three vascular strands running up to the stigma, there was only one vascular strand in each of the styles of the unusual type, thus showing it to be a simple division of the style into three.

Madras Herbarium, Coimbatore, *December* 16, 1946.

S. N. CHANDRASEKHARAN.
D. DANIEL SUNDARARAJ.

* Jacob, K. C., *Monograph on Madras Bananas* (Unpublished).

A NEW RECORD FOR *FRITSCHIELLA TUBEROSA* IYENG.

Fritschiella tuberosa Iyeng., a rare member of the order Chætophorales, is a subaerial alga which grows on drying cakes of mud in freshwater ditches. Its peculiar habit and occurrence point the way to the land habit as has been suggested by Iyengar (1932), and also by Singh (1942).

Singh (1941) who worked the autoecology and life-history of the species mentions the relevant literature and also the various situations in which it is found to occur. Iyengar "reported the plant growing on moist silt of drying rainwater pools in Madras, as well as at Talaguppa in the Mysore Province". Randhawa "records its growth in a drying pond and on the banks of the River Sarju", as well as from "fields lying fallow in the Fyzabad District". Singh found it on alkaline land some distance from the Benares Hindu University.

Recently, the author came across this alga in a similar situation to that described by Iyengar. At first it was found growing in association with *Protosiphon* and *Botrydium* as dark-green clusters on sloping ground by the side of a drying ditch seven miles south of Bangalore; and again in a drying pool near Malleswaram, Bangalore. In view of the very few localities in which this species has previously been found the present is an interesting record of its occurrence. What struck the author most, however, was the fact of its occurrence at two places in Mysore State which are situated in climatically diverse regions, Bangalore and Talaguppa being in the *Maidan* and *Malnad* parts of the State respectively.

I thank Dr. M. O. P Iyengar, who found the genus and species, for confirming my determination; and Dr. L. N. Rao for kind encouragement.

Central College, Bangalore, *December* 12, 1946.

BASHEER AHMED RAZI.

1. Iyengar, M. O. P., *New Phytologist*, **1932**, **31**, 329-35.
2. Singh, R. N., *ibid.*, 1941, **40**, 170-82.

CHROMOSOME NUMBERS IN *SESBANIA* SPP.

RECENTLY two notes[1,3] have been published in this *Journal* giving chromosome number counts in the Indian cultivated species of *Sesbania*. The notes showed that there was some discrepancy between the counts made by different observers. Further counts were made at the Agricultural College, Coimbatore, to find out if there was chromosome number variation within a single species of *Sesbania*. Either mitotic or meiotic chromosomes were counted in five varieties of *Sesbania*. Comparing the present results with previous records, the deductions are, (*a*) autopolyploidy occurs in *Sesbania aculeata*, and (*b*) *S. grandiflora* is probably constant in its chromosome number. The table given below brings out these points.

(*a*) The polyploid numbers in *S. aculeata* may be natural. Mr. Haque's new data[2] may be used to give this interpretation—the Andhra variety of *S. aculeata* is a diploid, and Benares and Coimbatore varieties are autopolyploids.

(*b*) Considering the general consistency in the genus, it is difficult to explain the count recorded by Krishnaswamy, *et al.*[4] In the pollen mother-cells of *S. grandiflora*, there is a considerable amount of secondary pairing and this feature will cause a reduction in the apparent number of bivalents counted at first metaphase. The present counts were made at diplotene, first anaphase, and at second telophase stages, in the P.M.C. in which stages the chromosomes are freer spatially.

Three varieties of *S. grandiflora* were grown at the Millet Breeding Station for this study. The varieties showed differences in vigour and rate of growth. The economic aspect of varietal differences will be studied and published later.

I am indebted to the Millet Specialist, Government of Madras, for facilitating and supervising this work.

Sesbania variety	2 n.	n.	Author
S. speciosa.	12	—	Present count.
S. aculeata, Benares var.	24	12	Haque.
do. Coimbatore var. .. .	24	—	Present count.
do. Andhra var.	—	6	Sundar Rao.
S. grandiflora Benares var.	24	12	Haque.
do. Andhra var.	24	12	Sundar Rao.
do. Madras var.	24	—	Present count
do. Coimbatore var	—	12	do
do. from Paddy Breeding Station, Coimbatore	—	12	do
do. do. ?	—	7	Krishnaswamy, *et al.*

Millet Breeding Station,
Coimbatore, S. SAMPATH.
December 11, 1946.

1. Haque. A., *Curr. Sci.*, **1946**, **15**, 78. 2. —, *ibid.*, **1946**, **15** 287. 3. Sundar Rao, Y., *ibid.*, **1946**, **15**, 78, 4. Krishnaswamy, N., and Rangaswamy Ayyangar, G. N., *ibid.*, **1935**, **3**, 488.

HEMILEIA JASMINI KRISHNAMURTHY AND RANGASWAMI SP. NOV. ON *JASMINUM RITCHIEI* CLARKE

DURING the month of September 1946 widespread incidence of a rust was observed on *Jasminum Ritchiei* growing wild at Yercaud, Shevaroy Hills, Salem District. Mr. K. M. Thomas, Government Mycologist, Madras, had collected a rust on the same host from Coorg in 1925. This specimen was compared with the present collection and the two rusts are found to be the same.

Light orange yellow powdery formation of the sori was present on the lower surface of the leaves. Urediosori were observed in plenty. The sorus was extra-stomatal; a fasciculate mass of hyphæ had developed through the stoma and borne the spores outside the surface of the leaf on short projections (Fig. 1). The spores were sub-globose or resembling the segments of an orange (Fig. 2). The wall was hyaline thicker and echinulate on all sides except the flattened or concave side. The contents were yellowish. The spores measured $24 \times 18\,\mu$ ($17{\cdot}5$-$29{\cdot}8 \times 14$-$24{\cdot}5\,\mu$).

Teliospores were very few. They were irregular, more or less hyaline, thin-walled, smooth and measured $27 \times 22\,\mu$ ($16{\cdot}5$-$38{\cdot}5 \times 14$-$31{\cdot}5\,\mu$). Some of them were hemispherical with the remnant of the stalk on one side; others were angular or other irregular forms (Fig. 3).

Several rusts have been recorded on *Jasminum* spp. from India. They are: *Chaconia Butleri* (Syd.) Mains.,[1] on *J. malabaricum* W.; *Uromyces hobseni* Vize,[2] on several species of *Jasminum*; *Uromyces comedens* Syd.[3] on *J. pubescens* Willd., and *Puccinia chrysopogi* Barclay[4] on *J. humile* L. and *J. Ritchiei*. The last was collected by Mr. Thomas from Coorg in 1925.

The rust now recorded is different from all the above in the peculiar formation of the uredio and teliosori and the characteristic shape of the spores. It is a *Hemileia*.

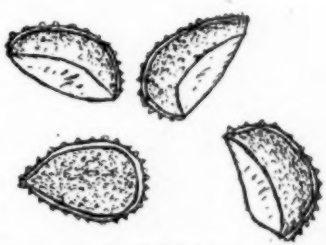


FIG. 1. Section of leaf showing the urediosorus × 660.
FIG. 2. Urediospores. × 660.

No species of this genus has been observed on *Jasminum* or allied genera of Oleaceas till now and, therefore, it is proposed to name this fungus *Hemileia jasmini* sp. nov.

Hemileia jasmini sp. nov. Urediosori Hypophyllous, gregarious, pulverulent, pale orange yellow, minute; urediospores sub-globose to orange-segment shape, $24 \times 18\,\mu$, unicellular, wall hyaline, thicker and echinulate except on the flattened or concave side. Contents light yellow; telia mixed with uredia; teliospores irregular, smooth, hyaline $27 \times 22\,\mu$.

On living leaves of *Jasminum Ritchiei* Clarke. Yercaud, Shevaroys (Salem District), 27-9-'46 (C. S. Krishnamurthy and G. Rangaswami) type deposited in the Herbarium of the Government Mycologist, Coimbatore, and Herb. Crypt. Ind. Orient., New Delhi.

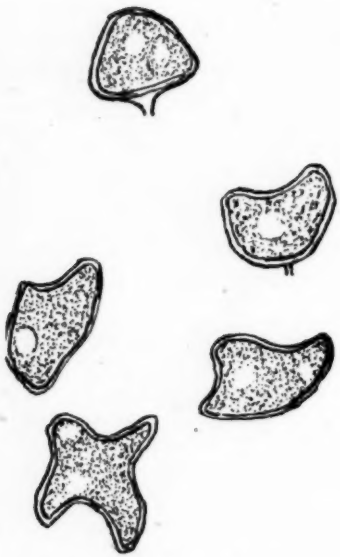


FIG. 3. Teliospores. × 600.

Hemileia jasmini sp. nov. Uredosori hypophylli, gregarii, pulverulenti, levis aurantini—flavi coloris minutissimi; uredeiosporia variantia sub-globosa ad aurantini—segmentiformia, 24 × 18 μ continua, paries hyalinus, crassuset echinulatis, non vero super planum vel concavum latus contenta levis flavi coloris; telia urediis mixta; teliospora, irregularia, hyaline laevia 27 × 22 μ.

In vivi foliis *Jasmini Ritchiei* Clarke. Yercaud, Shevaroys (Salem District) 27-9-1946 (Leg. C. S. Krishnamurthy et G. Rangaswami). Typi specimina deposita in Herbario, Government Mycologist, Coimbatore, et Herb. Crypt. Ind. Orient, New Delhi.

Our thanks are due to Rev. Fr. M. Singarayar of St. Joseph's Seminary, Coimbatore, for the Latin translation; to Mr. K. M. Thomas, Government Mycologist, for helpful suggestions; and to the Government Lecturing and Systematic Botanist, Agricultural College and Research Institute, Coimbatore, for identification of the host.

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G. RANGASWAMI.

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Coimbatore,
November 20, 1946.

1. Mains, E. B., *American Journal of Botany*, 1938, **25**, 678. Saccardo, P. A., *Syll. Fungorum*, **23**, 665. 2. Sydow, H., *et* Sydow, P., *Monographia Uredinearum* **2**, 38. 3. —, *ibid.*, **2**, 37. 4. —, *ibid.*, **1**, 746. 5. Butler, E. J., and Bisby, G. R., *Fungi of India*, pp. 65, 81 and 82.

DEVELOPMENT OF THE FISCHER-TROPSCH PROCESS IN GERMANY DURING THE WAR

A GIST of the developments made in Germany during the war in the Fischer-Tropsch process of making oils and waxes from coal was given in a recent press-release from the Department of Scientific and Industrial Research, London.

Altogether nine plants seem to have been engaged on this process, most of them operating at atmospheric pressure, while some others employed medium pressure of about ten atmospheres. The combined annual output of these plants was estimated at about 570,000 tons of total hydrocarbons, which is less than 8 per cent. of the total German production of oil during the war.

The gasification of hard-coke in normal water-gas generators was the principal method employed for preparing the synthesis gas, the required ratio of $CO : H_2$ (*viz.*, 1 : 2) being obtained either by catalytic conversion of part of the water-gas into hydrogen or by adding the hydrogen-rich gas obtained by cracking coke-oven gas in the presence of steam. Two of the plants prepared the synthesis gas by the direct gasification of brown coal.

The synthesis catalyst used in all the plants had the gravimetric composition of Co = 100, thoria = 5, MgO = 8, and kieselguhr = 200 and was prepared in the usual way by precipitation from solutions of the nitrates and reduced in hydrogen at about 400° C. under carefully controlled conditions.

The reaction temperature employed varied between 180° and 200° C. In order to dissipate the heat of the synthesis reactions, water-cooling devices were incorporated in the design of the reaction-chambers. The process was also conducted in two or three stages, with interstage cooling.

The reaction products, which were mainly straight chain paraffins and olefines, were recovered by cooling and adsorption on active carbon. They were fractionated and stabilised by conventional methods. Irrespective of the pressure used, the most efficient plants obtained yields of 160-165 g. of C_3 and higher hydrocarbons per cubic metre of inert-free synthesis gas, i.e., about 80 per cent. of the theoretical maximum yield.

While the lower fractions were used as power-fuels, most of the 230-320° cut was converted into "Mersol" soap-substitutes, by sulpho-chlorination, followed by saponification. Part of it was also cracked with soft wax to yield lubricating oils of good quality. The bulk of the soft-wax, however, was oxidised to produce fatty acids for use in the soap industry and in the production of edible fat. Most of the hard-wax found application in the wax industry for polishes, paper-impregnation, electrical insulation and the like.

A development worthy of special mention is the "Oxo-synthesis" in which the olefines react with carbon monoxide and hydrogen to form aldehydes. Although developed mainly for production of long-chain alcohols from Fischer-Tropsch olefines, this process is said to be of general application to compounds containing ethylenic linkages and has a great future.

M. V. C. SASTRI.

REVIEWS

Advances in Colloid Science, Vol. II—Rubber. Edited by H. Mark and G. S. Whitby. (Published by Interscience Publishers Inc., New York), 1946. Pp. 453. Price $7.00.

The book is a result of Anglo-American collaboration in presenting an up-to-date review of physico-chemical studies on rubber and related high polymers. The book contains the following sections, each written by a specialist of established reputation on his subject: —(1) Second Order Transition Effects in Rubber and other High Polymers. (2) Crystallisation Phenomena in Natural and Synthetic Rubbers. (3) The Study of Rubber-like substances by X-ray Diffraction Methods. (4) The thermodynamic Study of Rubber Solutions and Gels. (5) Significance of Viscosity measurements of dilute solutions of High Polymers. (6) The Kinetic Theory of Rubber Elasticity. (7) Vulcanisation. (8) Rubber Photogels and Photovulcanisates. (9) Reinforcing and other Properties of Compounding Ingredients.

The contributors have all recognised the fact that the study of natural rubber forms only a part of the broad field of rubber-like polymers and have, accordingly examined their subject from a comprehensive point of view which has thrown light on rubber-problems as a whole. In natural rubber, the isoprene units are all united in a cis-configuration, in the 1, 4-sense, while in synthetic butadiene polymers, there are both cis and trans- arrangements about the double bonds and also unions in the 1, 4-, 1, 2- and 3, 4-sense. A thorough physico-chemical study of long-chain molecules in general can only give the clues which will some day enable the synthetic chemist to produce at his will macro-molecules having a predetermined length and configuration. This book reveals the worldwide attention which this problem is receiving and the rapid progress which has been made in recent years; indeed the day may not be distant when tailor-made molecules will be commonplace materials.

The contributors have taken much for granted from their readers. The experimental technique which have been used for the solution of problems of major significance, have rarely been described. Complicated mathematical equations have been assumed to be common knowledge. The reviewer feels that a few appendices giving detailed information on these points would have added to the value of the book.

The authors have not only summarised modern researches but have examined critically how far the results of different investigators support or contradict one another and have presented a clear picture of the gaps in our knowledge which remain to be bridged. The book will be welcome to all those who are interested in a scientific study of the subject of high polymers.

J. C. G.

Progress in Science. By W. L. Sumner. (Basil Blackwell, Oxford), 1946. Pp. 176. Price 8*sh.* 6*d.* net.

This is a book which will interest the layman as well as the expert who wishes to have a general knowledge of the outstanding achievements of science in fields outside his own. The author has given a clear and popular account of (1) electrons and their uses in electron microscope, radio-location, television, (2) release of atomic energy, (3) jet propulsion and the gas turbine, (4) plastics, (5) chemotherapy including the story of sulphonamides and penicillin, and (6) plantgenetics, mutation of genes and doubling of chromosomes by artificial means. These discoveries open up wonderful possibilities for the well-being of mankind. They indeed herald the dawn of a new age of plenty, health and happiness, if man only has the wisdom not to use them as tools for his own destruction. Whatever happens, researchers having the true scientific spirit will always persue truth for its own sake, for the simple joy of discovery; and the author has done well in bringing out how advances in fundamental science have been responsible for the technological revolutions which we are witnessing to-day. The book is well worth perusal by persons who wish to have a cultivated mind.

J. C. G.

The Practice of Silviculture (5th edition). By R. C. Hawley. (John Wiley & Sons, Inc., New York; and Chapman & Hall, London), 1946. Pp. xi+354. 70 Figs. Price $4.

Earlier editions of this excellent book appeared in 1921, 1928, 1934 and 1937. During these 25 years great additions to the knowledge and practice of American silviculture have been made and this present edition, revised, enlarged and largely rewritten, is very different from the first edition.

It is intended as a text-book and deals almost entirely with American conditions. It begins by stressing the difference between *silvics* which deals with the fundamental laws underlying the growth and development of single trees and of the forest as a biological unit, and *silviculture* which is the art of producing and tending a forest, that is the appplication of the knowledge of silvics in the treatment of a forest.

The author divides the book into three main parts: (1) Treatment of the stand during the period of regeneration or establishment including a consideration of reproduction methods, (2) treatment of the stand during that portion of the rotation not included in the period of regeneration (this is a consideration of intermediate cuttings), and (3) protection of the stand against injuries of all kinds. Under (1) the following methods are considered:— (*a*) Clear cutting with both artificial and natu-

ral regeneration; (*b*) the seed tree method; (*c*) The shelter wood method; (*d*) the selection method; (*e*) the coppice method; and (*f*) the coppice with standards method.

It is refreshing to see this simple classification, for modern forestry has tended to consider modifications of these main methods as entirely separate methods and this tends to confuse the student.

Section 2 on intermediate cutting includes notes on thinnings, improvement and salvage cuttings, pruning and methods of control. Section 3 is comprehensive on all types of protection and is not usually found in text-books on silviculture.

A very welcome inclusion is a list of common and botanical names of the main American tree species.

Of great interest to Indian foresters are the changes of opinion which have occurred from edition to edition. One of the most striking is that in the 1921 edition the statement was made that "A general rule is not to make the first thinnings until the receipts will at least pay expenses". Craib's work on wattle thinnings in S. Africa has obviously had a lot to do with the change to the opinion in this present edition that the first thinnings should be carried out as soon as they are needed provided it appears that subsequent returns will justify the investment.

Some of the facts given in the first and last chapters are important. For example it is not generally realized that scientific American forestry is a very new thing and is still in an elementary stage as is shown by the fact that out of 509 million acres available for timber production only 21 per cent. is under "some technique of timber production" and only 6 per cent. is under fairly intensive management. As the author says, "Most of the forest area is still without any application of silviculture or else under a very simple form of forest management". He rightly stresses the need for the technical training of forest officers and for the education of the general public.

The book, as is usual in American publications, is well printed and well produced and illustrated with clear simple diagrams. It is complimentary to Toumey and Korstian's *Foundations of Silviculture upon an Ecological Basis* (1937) and these two books should be in the library of every forest officer.

A. L. GRIFFITH.

An Introduction to Textile Bleaching. By J. T. Marsh. (Chapman & Hall, Ltd., Essex St., London.) First edition, Demy 8vo. Pp. 512 + 154 Illustrations. 23*sh.* net.

The publication of this extremely useful book fulfils the long-felt need of a co-ordinated account of the extensive research work carried out by different investigators and the large amount of experience gained in the wet processing of textiles. The author has incorporated most of the important information available in scientific journals. The book is a comprehensive survey in what latest advances and the earlier researches have been carefully blended. The sequence of processes is suitably arranged and carefully developed so as to bring out most of the practical and theoretical aspects of this important branch of textile technology.

The book is divided into six parts and each part deals with a specific subject in textile bleaching.

Part I gives an up-to-date account of the chemistry of the various textile fibres and covers 101 pages. The physics and chemistry of cellulose and other textile fibres is so fully treated in the author's own book, *An Introduction to the Chemistry of Cellulose* that this might have been largely omitted from the present volume but for those portions directly related to the bleaching processes. This is followed by Part II dealing with wetting and detergency. A large amount of information has been included in this section but one feels the lack of a systematic arrangement of the various aspects of wetting and detergency.

The scouring and bleaching of cellulosic fibres are dealt with in Part III. A note on the evaluation of desizing agents and on the examination of Kier boiling efficiency would have been welcome. A diagramatic illustration of a modern gas singeing machine should have been included in the portion of 'Singeing'. Bleaching of coloured goods has been summarily disposed off without proper justice and deserves greater attention.

The chemical technology of the most important animal fibres, wool and silk forms the subject matter of Part IV. The physico-chemical aspect of degumming of silk has been well reviewed. The scouring of wool appears to be incomplete without a reference to the useful work of Dr. Zakarias in the field of Collective Chemistry.

The fifth part deals with drying of textiles. The modern development in drying machinery have been reviewed and well illustrated. The sixth section deals with damage to textile fibres and its evaluation. The inclusion of this section is very appropriate and useful from the point of view of the processor.

The book is well illustrated with neat sketches and photographs of most of the important machines used in wet processing of textiles. A chapter dealing with different types of drives, bearings and their lubrication common in such machines would have increased the usefulness of the book all the more. Nevertheless, the book is of great value not only as a text-book but also as a reference book to the processor and the research worker. Mr. Marsh has made a very valuable contribution to textile chemistry literature.

G. M. NABAR.

Fruit Fall and Its Control by Synthetic Growth Substances. By M. C. Vyvyan. (Imperial Bureau of Horticulture and Plantation Crops. Technical Communication No. 18), 1946. Pp. 1-72. Price 3*sh.* 6*d.*

One of the serious problems that confront orchardists all over the world is the loss in yield due to pre-harvest drop of fruits. If this loss, which at times could be considerable, be checked the orchardists would benefit a great deal. The causes of abnormal shedding of blossom, of young fruit, and of nearly mature fruit, has engaged the attention of several of

the horticultural workers in many countries for a number of years in the past. The experiences of these workers have not been easily available in the past except to a limited few. The results of such previous work, although not been very successful, had furnished much useful information to form the basis of more recent attempts at preventing premature fall of fruit.

In recent years synthetic growth substances have been successfully used by practical horticulturists in inducing quicker and better rooting of cuttings of many plants. Some practical results have also been obtained in inducing parthenocarpy and there appears to be great possibilities of successful use of these substances in effecting good grafts. The success attained in these directions have led some workers to test the possibilities of growth substances in retarding fruit fall. The measure of success attained so far, though restricted to some varieties of fruits, has opened up the possibilities of discovering new substances which will work with varieties which have failed to respond to substances now used. The results obtained in controlling fruit drop by the use of synthetic growth substances forms the subject-matter of the publication under review.

The author has done a commendable piece of work in dealing with so many aspects of the work in such brief manner. The publication is divided into six parts. The first part deals with the causes of loss of potential fruit, *viz.*, pre-blossoming losses, shedding of blossom and young fruit and pre-harvest drop. Under each sub-head the various principal and contributory causes are dealt with. In the second part is described the formation of abscission which is the underlying cause of shedding of fruit. The varietal differences to abscission process, causes affecting abscission and the effect of growth substances on this process are discussed. The third part is devoted to the experimental procedure, *viz.*, the different methods tested, systems of recording and presentation and interpretation of the exeperimental results. The fourth part which is the longest has for its subject the effect of growth substances on pre-harvest drop. A brief tribute is paid to pioneer work of Gardner, Marth and Batjer of which all subsequent works is an elaboration. The varietal difference in response, method and time of application, types of substances used and their concentration, compatibility of these substances with insecticides and fungicides, and their effect on quality of fruit are concisely dealt with. This part is concluded with a reference to other effects of the growth substances such as on disease of fruits, physiological processes, on young developing parts, leaf fall and the harmlessness of the substances to animals, etc. Part five contains practical recommendations and the final part includes tabular summary of the important results cited and a very useful bibliography.

The above publication will be found to be of inestimable value to fruit growers all over the world who are faced with the loss of potential fruit due to pre-harvest drop. The author deserves the thanks of all horticulturists for compiling together such important results not easily accessible and presenting it in such brief manner. It is needless to say that the Imperial Bureau of Horticulture and Plantation Crops has rendered great service in bringing out this very useful publication, the results of which cannot easily be assessed.

L. S. S. K.

SCIENCE NOTES AND NEWS

University of Madras Endowment Lectureships, 1947-48.—The Syndicate will proceed shortly to select persons to deliver lectures under the following Endowments for the year 1947-48. Applications for Lectureships will be received by the undersigned not later than the 15th March 1947. Applicants are requested to give full particulars regarding their qualifications, etc., and the subject selected by them for the lectures. The lectures are to be delivered before January 1948. Separate application should be submitted for each lectureship.

The principal terms and conditions of award are given below :—

(1) *The Maharaja of Travancore Curzon Lectureships.*—Three lectureships of the value of Rs. 250 each, relating to (*a*) Medicine—Clinical, (*b*) Engineering, and (*c*) Agriculture. Applicants should be graduates of the University.

(2) *The Sir Subrahmanya Ayyar Lectureship.*—Value Rs. 250. The lectures should be on a subject connected with Physical Science. Applicants should be graduates of the University.

(3) *The Sankara Parvathi Lectureship.*—Value Rs. 250. The lectures should be on a subject connected with Ancient South Indian History. Applicants should be graduates of the University.

(4) The Sir William Meyer Lectureship.—Value Rs. 1,500. A course of not less than six lectures should be delivered on a subject in Economics. Half of the remuneration will be paid after the delivery of the lectures and the other half after the publication of the lectures.

(5) *The Principal Miller Lectureship.*—Value Rs. 350. A course of not less than two lectures should be delivered on a subject dealing with the Exposition of the Inner Meaning of Human History as disclosing the one Increasing Purpose that runs through the Ages.

(6) *The Dr. Elizabeth Matthai Lectureship.*—Value Rs. 300. A course of not less than three lectures should be delivered on a subject embodying the results of original investigation in some branch of Medicine and Surgery. Preference will be given to a subject having special reference to the requirements of women and children.

(7) *The Sundaram Ayyar–Krishnaswami Ayyar Lectureship.*—Value Rs. 200. The subject of lectures should be one relating to (*a*) Public International Law, or (*b*) Inter-State Relations of Indian States with British Indian Provinces, or (*c*) Comparative Legislation.

(8) *The Diwan Bahadur K. Krishnaswami Rao Lectureship.*—Value Rs. 200. The subject of lectures should be one relating to some aspect of Ancient Indian Culture studied from Original Sources.

(9) *The Father P. Carty Lectureship.*—Value Rs. 200. The subject of lectures should be one connected with Economics with particular reference to Indian conditions.

Lady Tata Memorial Trust: Scientific Research Scholarships, 1947-48.—The Trustees of the Lady Tata Memorial Trust are offering six Scientific Research Scholarships of Rs. 250 each per month for the year 1947-48 commencing from 1st July 1947. Applicants must be of Indian nationality and Graduates in Medicine or Science of a recognised University. The scholarships are tenable in India only and the holders must undertake to work wholetime under the direction of the head of a recognised Research Institute or Laboratory. The subject of scientific investigation must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications must reach by March 15, 1947. Further particulars can be had from the Secretary of the Trust, Bombay House, Bruce Street, Fort, Bombay.

Frans Verdoorn, First Recipient of Mary Soper Pope Medal.—The first Mary Soper Pope Medal of the Cranbrook Institute of Science, Michigan, has been awarded (Dec. 12, 1946) to Dr. Frans Verdoorn, Editor of *Chronica Botanica*, of Waltham, Mass., in recognition of his editorial and international relations work in biology as well as for his researches in cryptogamic botany and the history of the plant sciences.

Dr. Verdoorn, who was born at Amsterdam, the Netherlands, in 1906, came to the U.S.A. in 1940. He is the Managing Editor of the Chronica Botanica Co., which publishes *Chronica Botanica*, "A New Series of Plant Science Books", and *Annales Cryptogamici et Phytopathologici*. He is also Botanical Secretary of the International Union of Biological Sciences and Special Adviser to the Netherlands Indies Department of Agriculture. His principal books are: *de Frullaniaceis I-XVIII, Manual of Bryology, Manual of Pteriodology, Plants and Plant Sciences in Latin America, Science and Scientists in the Netherlands Indies* (with P. Honig) and the *Index Botanicorum*, a biographical dictionary of plant scientists, now in preparation in co-operation with the Arnold Arboretum of Harvard University, with which Verdoorn has been connected since 1941. From January 1947 onwards Verdoorn will issue a monthly biological newsletter, *Biologia*, and an annual review of progress, in international relations and co-operation in science, to be entitled *Pallas*.

Indian Ecological Society.—The Sixth Annual General Meeting of the Indian Ecological Society was held at Delhi in the Botany Section of the Indian Science Congress, on 4th January 1947, at 2 p.m., when Dr. S. L. Hora and Dr. F. R. Bharucha were elected President and General Secretary of the Society respectively for 1947.

Indian Chemical Society.—The 23rd Annual General Meeting of the Indian Chemical Society was held on January 3, 1947, at the venue of the Indian Science Congress at Delhi, under the chairmanship of Dr. J. N. Mukherjee, the President. Election of the Office-bearers, four Members of the Board of Editorial Correspondents, two Honorary Auditors and four Ordinary Members of the Council was announced. Prof. P. Ray and Dr. B. N. Ghosh were respectively elected President and Secretary of the Society. The President addressed the meeting "On the Role of Chemists in the Promotion of Chemical Science, Research and Industries".

We acknowledge with thanks the receipt of the following:—

(1) *The Trematoda (with special reference to British and other European forms)*. By Ben Wawes. (Cambridge University Press), 1946. Price 52/6 net.

(2) *Hydraulic Measurements* (II Edn.). By Herbert Addison. (Chapman & Hall), 1946. 21/- net.

(3) *Methods of Plane Projective Geometry* (based on the use of general homogeneous coordinates). By E. A. Maxwell. (Cambridge University Press), 1946. 12/6 net.

(4) *Electronic Theory of Acids and Bases*. By Luder and Zuffauti. (John Wiley & Sons, Inc., N.Y., and Chapman & Hall, London), 1946. $3.00.

(5) *Forensic Chemistry*. By Henry T. F. Rhodes. (Chapmann & Hall), 1946. 15/-.

(6) *Chemotherapy—Yesterday, To-day and To-morrow*. By Fleeming. (Cambridge University Press), 1946. 2/-.

ERRATA

Vol. 15, *No.* 11, *November* 1946

Page 302, line 24: Under "Aviation Radio", *for* "Ultra-violet wave", *read* "Ultra-short wave"; lines 29 and 30: *for* "air port", *read* "air ports"; *for* "aircraft" *read* "aircrafts"; line 31: *for* "maker" *read* "marker". Under "Radio Direction Finding", line 25: *for* "makers", *read* "markers".

Page 304, line 7: Under "Radar and Associated Systems", *for* "impulse-modulated" *read* "pulse-modulated".

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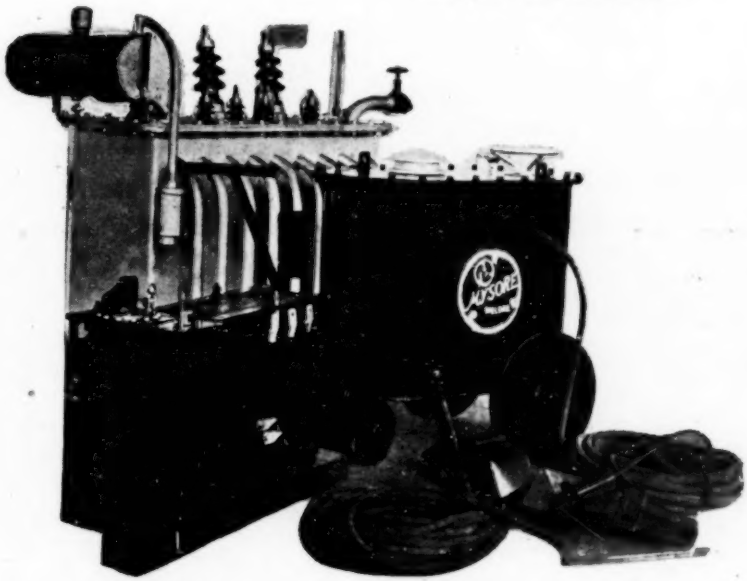

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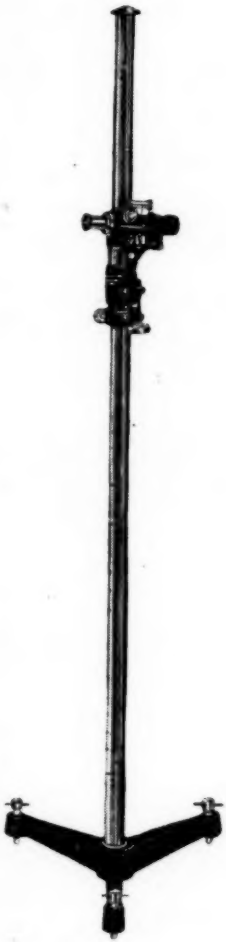

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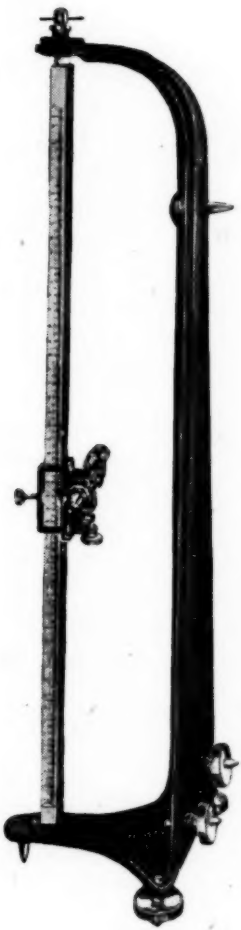

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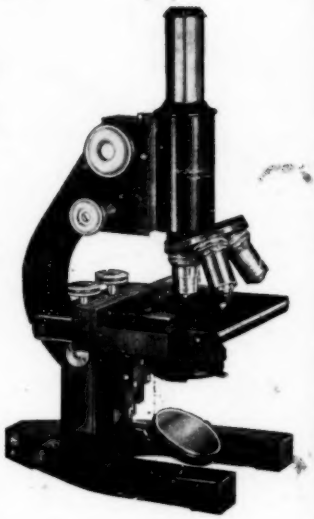

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